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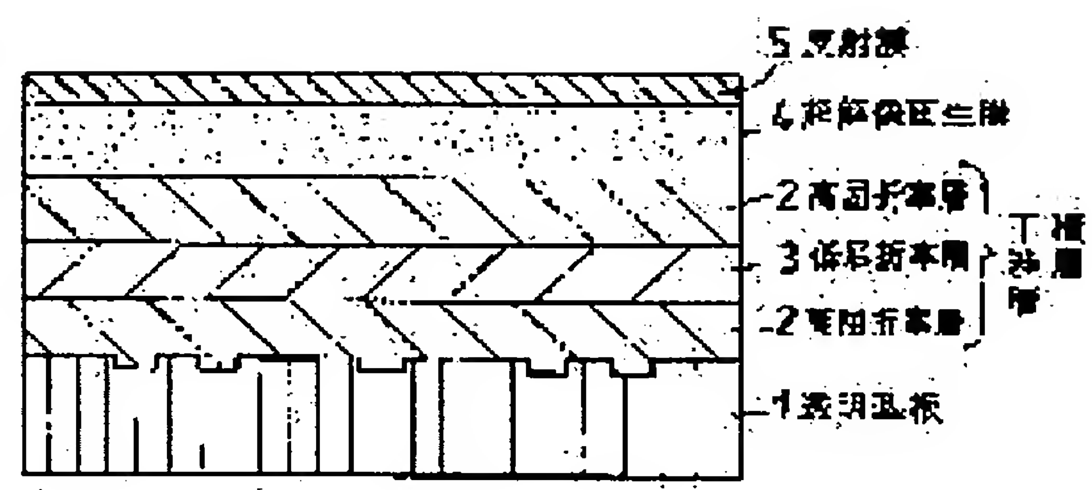
(54) OPTICAL RECORDING MEDIUM

(57)Abstract:
PROBLEM TO BE SOLVED: To enlarge the difference between the reflection factors of an optical mask part and an optical opening part of an optical recording medium provided with a super-high resolution reproducing film.
SOLUTION: In the optical recording medium in which the optical opening part and the optical mask part are formed corresponding to the distribution of the intensity of reproduced light by successively laminating a transparent substrate 1 having a role as a recording layer, a super-high resolution reproducing film 4 whose refractive index is changed corresponding to the intensity of incident light and a reflection film 5 and which reads the recorded information written with a minuter pitch compared with an irradiation light spot, the reproduced light is multiple-reflected in a laminated interference layer 11 and incident light and reflected light are multiple-interfered by inserting the laminated interference layer 11 consisting of a high refractive index layer 2, a low refractive index layer 3 and a high refractive index layer 2 each having an optical film thickness of λ/4, between the super-high resolution reproducing film and the reflection film to enlarge the difference between the reflection factors of the optical recording media in the region (optical opening part) having changed refractive index and in the region (optical mask part) having unchanged refractive index of the super-high resolution reproducing film.



CLAIMS

[Claim(s)]
[Claim 1]A transparent substrate.
A layered product which consists of a super-resolution-reproducing film from which a refractive index changes when a dose of a recording layer and an interference layer which countered this transparent substrate, were provided and were laminated by order arbitrary between a reflecting layer which reflects light irradiated from said transparent substrate side, and said substrate and said reflecting layer, and said light exceeds a predetermined threshold.
Are the above the optical recording medium which it had, and said interference layer, It is characterized by being the lamination interference layer which laminated at least three layers which consist of the 1st high refractive index layer that has a predetermined refractive index, low refractive index layers whose refractive index is lower than these 1st refractive index layers, and the 2nd refractive index layers whose refractive index is higher than this low refractive index layer sequentially from said transparent substrate side.

[Claim 2]A difference of a refractive index in early stages of said super-resolution-reproducing film, and a refractive index when it changes deltan, The optical recording medium according to claim 1 characterized by filling delta R/d>delta n/n>0.007 when thickness of deltaR (0< R<=1) and said super-resolution-reproducing film is set to d (nm) for a difference of reflectance when a refractive index of said super-resolution-reproducing film changes.
[Claim 3]A transparent substrate which has recorded information.
A layered product which consists of a super-resolution-reproducing film from which a refractive index changes when a dose of an interference layer and said light which countered this transparent substrate, were provided and were laminated by order arbitrary between a reflecting layer which reflects light irradiated from said transparent substrate side, and said substrate and said reflecting layer exceeds a predetermined threshold.
Are the above the optical recording medium which it had, and said interference layer, It is characterized by being the lamination interference layer which laminated at least three layers which consist of the 1st high refractive index layer that has a predetermined refractive index, low refractive index layers whose refractive index is lower than these 1st refractive index layers, and the 2nd refractive index layers whose refractive index is higher than this low refractive index layer sequentially from said transparent substrate side.

[Claim 4]The optical recording medium according to claim 1 having the optical matching layer which controlled a refractive index or thickness to make reflectance of an optical recording medium into the minimum at the time of an optical exposure which adjoins said super-resolution-reproducing film, is provided, and does not exceed said threshold.
[Claim 5]An optical recording medium comprising:
A transparent substrate.
A reflection film which reflects light in which this transparent substrate is countered and it is provided, and which is irradiated from said transparent substrate side.
A super-resolution-reproducing film to which a refractive index is changed when it is formed between said transparent substrate and said reflection film and an optical dose exceeds a predetermined threshold.
A low refractive index layer whose refractive index is lower than a refractive index of said super-resolution-reproducing film when it irradiates with light which is formed in this super-resolution-reproducing membrane surface, and does not exceed said predetermined threshold, A recording layer which was formed in this low refractive index layer surface, and was formed between a high refractive index layer whose refractive index is higher than said low refractive index layer, between said transparent substrate and a super-resolution-reproducing film or said high refractive index layer, and a reflecting layer.

[Claim 6]A reflection film which reflects light in which this transparent substrate is countered the transparent substrate side, and it is provided, and which is irradiated from said transparent substrate side, A super-resolution-reproducing film from which a refractive index changes with

the optical exposures of intensity exceeding a predetermined threshold formed between said substrate and a reflection film, Catoptric light by said reflection film to regenerated light which possesses an interference layer and a recording layer and is irradiated from said transparent substrate side, In an optical recording medium which makes an interference light with catoptric light by said interference layer and said super-resolution-reproducing film catoptric light of an optical recording medium and with which reflected light intensity differs corresponding to a refractive index changing region of said super-resolution-reproducing film, An optical recording medium, wherein said interference layer is a lamination interference layer which laminated a high refractive index layer and a low refractive index layer from which a refractive index differs so that said regenerated light may carry out a multiple echo within a recording medium.
[Claim 7]A reflection film which reflects light in which this transparent substrate is countered the transparent substrate side which has recorded information, and it is provided, and which is irradiated from said transparent substrate side, Catoptric light by said reflection film to regenerated light which possesses a super-resolution-reproducing film from which a refractive index changes, and an interference layer, and is irradiated from said transparent substrate side by optical exposure of intensity exceeding a predetermined threshold formed between said substrate and a reflection film, In an optical recording medium which makes an interference light with catoptric light by said interference layer and said super-resolution-reproducing film catoptric light of an optical recording medium and with which reflected light intensity differs corresponding to a refractive index changing region of said super-resolution-reproducing film, An optical recording medium, wherein said interference layer is a lamination interference layer which laminated a high refractive index layer and a low refractive index layer from which a refractive index differs so that said regenerated light may carry out a multiple echo within a recording medium.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]Especially this invention relates to the optical recording medium possessing a super-resolution-reproducing film with respect to an optical recording medium.
[0002]
[Description of the Prior Art]Optical disk memory which performs reproduction of information, or record and reproduction by the exposure of an optical beam is put in practical use by various files, such as a sound, a picture, and computer data, as memory storage which has large scale nature, rapid access nature, and medium portability.
The development continues to be expected.

[0003]As densification art of an optical disc, the short wavelength formation of the gas laser for original recording cutting, the short wavelength formation of the semiconductor laser which is a

light source of operation, high-numerical-aperture-izing of an object lens, and sheet metal-ization of the optical disc are considered. In a recordable optical disc, there are various approaches, such as mark length record and land groove recordings.
[0004]The super resolution art using a medium film is proposed as art in which the effect of the densification of an optical disc is large. although super resolution art was proposed as art peculiar to a magneto-optical disc at the beginning, the trial with which a ROM disk also provides and carries out super resolution reproducing of the super resolution film from which the transmissivity of light changes with the exposures of regenerated light to the regenerated light exposure side to a recording layer is reported after that. Thus, super resolution art was understood that it can apply to all the optical discs, such as a magneto-optical disc, CD-ROM, CD-R, WORM, and a phase change type optical recording medium.
[0005]The super-resolution-reproducing film proposed with the conventional super-resolution-reproducing art is divided roughly into a heat mode method and a photon mode method. By a heat mode method, a super-resolution-reproducing film is made to generate a phase transition etc. with heating by regenerated light exposure, and an optical opening with high transmissivity is formed. The shape of this optical opening becomes the same as that of the constant temperature line of a super-resolution-reproducing film.
[0006]By a photon mode method, coloring or the decolorization by regenerated light exposure is used, using a photochromic material as a super-resolution-reproducing film. An electron excites a photochromic material from a ground level from an optical exposure to a short-life excitation state, and it reveals change of light absorption characteristics by changing to very long-life metastable excitation level, and being further, caught from excitation level. Therefore, it is necessary to carry out deexcitation of the electron caught by metastable excitation level to a ground state for reproducing repeatedly, and to close the once formed optical opening. There is also an example using the semiconductor continuation film or semiconductor particulate dispersion film which used absorption saturation phenomena as a super-resolution-reproducing film of a photon mode method.
[0007]which method -- an imitation -- depending on the grade of change of the optical constant by optical exposure, the characteristic of a super-resolution-reproducing film enlarges the reflectance difference of an optical opening part with high reflectance, and an optical mask part with low reflectance within light spot, so that change of an optical constant is large. However, in order that the variation of an optical constant may be dependent on the material, change of a refractive index is enlarged and there is a limit in enlarging a reflectance difference. When a reflectance difference could not be enlarged and super resolution reproducing is carried out, there is a possibility that the reading failure of recorded information may occur.
[0008]
[Problem(s) to be Solved by the Invention]As mentioned above, when the reflectance difference of an optical mask part and an optical opening part could not be enlarged in the optical recording medium which uses a super-resolution-reproducing film, there was a problem that recorded information was correctly unreproducible.
[0009]This invention is made in view of such a problem, and is a thing.
It is providing the optical recording medium which can reproduce correctly the information which enlarged the reflectance difference of the purpose and an optical mask part, and was recorded with high density.

[0010]
[Means for Solving the Problem]. An optical recording medium of this invention was laminated by order arbitrary between a transparent substrate, a reflecting layer, and said substrate and a reflecting layer. In an optical recording medium to provide, a layered product which consists of a super-resolution-reproducing film from which a refractive index changes when a recording layer, an interference layer, and an optical dose exceed a predetermined threshold said interference layer, It is characterized by being the lamination interference layer which laminated at least three layers which consist of the 1st high refractive index layer that has a predetermined refractive index, low refractive index layers whose refractive index is lower than these 1st refractive index

layers, and the 2nd refractive index layers whose refractive index is higher than this low refractive index layer sequentially from said transparent substrate side.
[0011]That is, the multiple echo of the light irradiated an optical recording medium is carried out, and it is characterized by enlarging change of reflected light intensity corresponding to a refractive index change of a super-resolution-reproducing film by detecting catoptric light which carried out multiple interference within an optical recording medium.
[0012]As for thickness of said 1st [the] thru/or the 3rd interference layer, it is preferred to use lambda / about 4 substantially to the wavelength lambda of regenerated light with which an optical recording medium is irradiated.
[0013]When thickness of deltaR (0< R<=1) and said super-resolution-reproducing film is set [change of a refractive index when a refractive index of said super-resolution-reproducing film changed] to d (nm) for a difference of reflectance of deltan and an optical recording medium, it is desirable to fill delta R/d>delta n/nx0.007.
[0014]That is, it becomes possible to enlarge change of reflected light intensity corresponding to a refractive index change of a super-resolution-reproducing film by enlarging deltaR/d more to deltan/n. It is making the number of laminations increase in combination of a high refractive index layer and a low refractive index layer to a ****** interference layer, and, specifically, it becomes possible to enlarge change of reflected light intensity more.
[0015]Said transparent substrate can serve as said recording layer.
[0016]It is desirable to insert an optical matching layer between said interference layer and a reflecting layer.
[0017]Another recording medium of this invention comprises:
Transparent substrate.
Reflection film.
A super-resolution-reproducing film to which a refractive index is changed when it is formed between said transparent substrate and a reflection film and an optical dose exceeds a predetermined threshold.
A low refractive index layer whose refractive index is lower than a refractive index of said super-resolution-reproducing film when it irradiates with light which is formed in this super-resolution-reproducing membrane surface, and does not exceed said predetermined threshold, A recording layer which was formed in this low refractive index layer surface, and was formed between a high refractive index layer whose refractive index is higher than said low refractive index layer, between said transparent substrate and a super-resolution-reproducing film or said high refractive index layer, and a reflecting layer.

[0018]A reflection film which reflects light in which another optical recording medium of this invention counters this transparent substrate the transparent substrate side, and is formed, and which is irradiated from said transparent substrate side, A super-resolution-reproducing film from which a refractive index changes with the optical exposures of intensity exceeding a predetermined threshold formed between said substrate and a reflection film, Catoptric light by said reflection film to regenerated light which possesses an interference layer and a recording layer and is irradiated from said transparent substrate side, In an optical recording medium which makes an interference light with catoptric light by said interference layer and said super-resolution-reproducing film catoptric light of an optical recording medium and with which reflected light intensity differs corresponding to a refractive index changing region of said super-resolution-reproducing film, Said interference layer is characterized by being the lamination interference layer which laminated a high refractive index layer and a low refractive index layer from which a refractive index differs so that said regenerated light may carry out a multiple echo within a recording medium.
[0019]The transparent substrate side in which another optical recording medium of this invention has recorded information, A reflection film which reflects light in which this transparent substrate is countered and it is provided, and which is irradiated from said transparent substrate side, Catoptric light by said reflection film to regenerated light which possesses a super-resolution-reproducing film from which a refractive index changes, and an interference layer, and

is irradiated from said transparent substrate side by optical exposure of intensity exceeding a predetermined threshold formed between said substrate and a reflection film, In an optical recording medium which makes an interference light with catoptric light by said interference layer and said super-resolution-reproducing film catoptric light of an optical recording medium and with which reflected light intensity differs corresponding to a refractive index changing region of said super-resolution-reproducing film, Said interference layer is characterized by being the lamination interference layer which laminated a high refractive index layer and a low refractive index layer from which a refractive index differs so that said regenerated light may carry out a multiple echo within a recording medium.

[0020]That is, as long as it is the composition which a multiple echo and interference produce within an optical recording medium, a lamination interference layer may be laminated, for example in order of a low refractive index layer, a high refractive index layer, and a low refractive index layer not only in order of a high refractive index layer, a low refractive index layer, and a low refractive index layer.

[0021]Also in these optical recording media, since a multiple echo and catoptric light which carried out multiple interference are detectable, change of reflected light intensity corresponding to a refractive index change of a super-resolution-reproducing film can be enlarged more.

[0022]

[Embodiment of the Invention]Drawing 1 is a sectional view showing an example of the optical recording medium of this invention.

[0023]Recorded information is formed in the transparent substrate 1 which consists of quartz substrates (refractive index 1.45) as a pit. On this transparent substrate, the lamination interference layer 11 to which the plural laminates of the low refractive index layer 3 of optical film thickness lambda / 4 which consists of the high refractive index layer 2 (refractive index 2.35) and MgF_2 (refractive index 1.4) of optical film thickness lambda / 4 which consist of ZnS(s) were carried out is formed. Furthermore on the lamination interference layer 11, the super-resolution-reproducing film 4 and the reflection film 5 are laminated one by one.

[0024]Said refractive index and optical film thickness are against light with a wavelength of 410 nm. Therefore, thickness of the high refractive index layer is set to 43.6 nm and thickness ha70.7nm of a low refractive index layer.

[0025]To the light which does not exceed the threshold mentioned later, the refractive index used the thing of 2.0 and the super-resolution-reproducing film set it to the thickness from which the reflectance of an optical recording medium becomes the minimum, and 86.5 nm to the light which does not exceed a threshold.

[0026]In such an optical recording medium, said reflectance of the regenerated light irradiated from the transparent substrate side, By the strength of the interference light of the light reflected by the reflection film and the light which carries out a multiple echo within a lamination interference layer, determine and this invention, It makes it possible to enlarge the S/N ratio of the optical mask and optical opening which are formed with a super-resolution-reproducing film by observing the interference light of the light reflected with the reflection film, and the light which carried out the multiple echo by the lamination interference layer.

[0027]First, the reflectance of a lamination interference layer is explained.

[0028]The sectional view of a lamination interference layer is shown in drawing 2, and the reflectance of a lamination interference layer is shown in drawing 3. However, the refractive index of each class shall be the value mentioned above, and there shall be no wavelength dispersion.

[0029]Drawing 2 is formed from the transparent substrate 1 and the lamination interference layer 11, and the composition is the same as that of what was shown in drawing 1.

[0030]Among drawing 3, R (H) shows reflectance when R (HLHLH) laminates a high refractive index layer and five layers of low refractive index layers by turns, when 1 stratification of the high refractive index layer is carried out on a quartz substrate, and R (HLH) forms three layers, a high refractive index layer, a low refractive index layer, and a high refractive index layer, on a quartz substrate (composition shown by drawing 2).

[0031]In R (H), maximum reflectance is low, and the wavelength area which changes from a high

reflectance belt to a low reflectance belt is large so that drawing 3 may show. On the other hand, in R (HLH) (i.e., when a multiple echo arises between the layers of the high refractive index layer of a couple), the wavelength area which maximum reflectance increases and changes from a high reflectance belt to a low reflectance belt becomes narrow. That is, the steepness of a refractive index change increases. It is so remarkable that the number of laminations of a low refractive index layer and a high refractive index layer increases (i.e., so that the opportunity of this to carry out a multiple echo increases) (about the numerical orientation method of reflectance.). It indicates to " translation Nikkan Kogyo Shimbun" besides Shigetaro Ogura written by optical thin film H.A.Macleod, and " Kozo Ishiguro edited by optical thin film 2nd edition Shiro Fujiwara, Hideo Ikeda and KYORITSU SHUPPAN written by Hideji Yokota."
[0032]The reflection spectrum which changed and calculated the number of laminations of the lamination interference layer of the optical recording medium of the structure shown in drawing 1 was shown in drawing 4. It turns out that the difference of maximum reflectance and the minimum reflectance becomes large, and change is steep as the number of laminations increases. Like drawing 3, cross protection shows up notably and the steepness of this tendency of a reflectance change increases as the number of laminations increases.
[0033]Next, the reflectance of an optical recording medium in case the refractive indicees of the super-resolution-reproducing film of drawing 1 differ is shown in drawing 5. As shown in drawing 5, the wavelength from which a refractive index follows on increasing and reflectance serves as the minimum shifts to the long wavelength side.
[0034]For example, when the refractive index of a super resolution re-film changes to 1.8 from 1.7, the reflectance difference of the light near the wavelength of 410 nm changes to about about 0.7.
[0035]This reflectance difference is made so greatly that a reflectance change is steep so that drawing 5 may also show.
[0036]Next, a super-resolution-reproducing film is explained.
[0037]The super-resolution-reproducing film concerning this invention to the light below a predetermined threshold A predetermined refractive index. It has (it is hereafter called an early refractive index), and only the portion with which the light exceeding a predetermined threshold was irradiated is a film formed from the material which changes to a selectively different refractive index (it is hereafter called the refractive index at the time of super resolution reproducing), and, generally the thing of a heat mode system and a photon mode system is known.
[0038]With the super-resolution-reproducing film of a heat mode system, only the portion which exceeds a threshold with heating by optical beam exposure is selectively generated for a phase transition etc., and a refractive index is changed. For example, thermochromic materials, such as phase change materials, such as GeSbTe of a chalcogen system and AgInSbTe, a BIANSURON system, and a spiropyran, etc. are mentioned.
[0039]That for which the super-resolution-reproducing film of a photon mode system used coloring or decolorization, for example by optical exposures, such as a photochromic material, is mentioned. An electron excites a photochromic material from regulation ranking from an optical exposure to a short-life excitation state, and a refractive index is selectively changed by changing to very long-life metastable excitation level, and being further, supplemented from excitation level. Specifically, a PIROBENZO pyran series molecule, a fulgide system molecule, a diaryl ethene system molecule, a cyclophane system molecule, azobenzene, etc. are mentioned. A semiconductor, a semiconductor particulate dispersion film, etc. from which an optical constant changes with absorption saturation are mentioned.
[0040]Although there are what changes to a high refractive index to the light exceeding a threshold, and a thing which changes to a low refractive index in such a super-resolution-reproducing film, the super high resolution reproduction method in the case of the former is explained here.
[0041]The refractive index change of the super-resolution-reproducing film to the intensity of an optical beam is illustrated to the intensity distribution of the optical beam sent to drawing 6 (a) by laser, and (b). (c) shows the top view showing the optical property of an optical recording

medium when this super-resolution-reproducing film is used for the optical recording medium shown in drawing 1.

[0042]Intensity becomes weaker as an optical beam has intensity distribution as generally shown in drawing 6 (a), and it separates from the center of a beam. A super-resolution-reproducing film changes a refractive index from the early refractive index n to n1 to the optical beam exceeding a threshold. Here, when the wavelength of n= 1.7, n= 1.8, and an optical beam is 410 nm, as shown in drawing 5, in the position of the refractive index 1.7, reflectance will be about 2%, and reflectance will be about 70% in the position of the refractive index 1.8.

[0043]Therefore, as shown in drawing 6 (c), only the field where the refractive index changed reflects light also in light spot S, In the position of an early refractive index, light is not reflected, i.e., an optical opening part is formed, only the light irradiating part exceeding a threshold detects the recorded information on the range corresponding to this optical opening part, an optical mask part is formed in the light irradiating part below a threshold, and the recorded information on the range corresponding to this optical mask is not detected. Therefore, a light spot S twist also makes possible reading of recorded information, i.e., super resolution reproducing, with a narrow pitch.

[0044]Adjustment of the value of the optical recording medium at the time of an early refractive index adjoins a super-resolution-reproducing film, can form an optical matching layer, and not only the method of controlling the thickness of a super-resolution-reproducing film but can adjust the refractive index and thickness of a matching layer according to the early refractive index and thickness of a super-resolution-reproducing film.

[0045]Although drawing 5 explained the case where the refractive index in early stages of a super-resolution-reproducing film was 1.7, the case where an early refractive index is 2.3 similarly is examined.

[0046]The optical recording medium in which the characteristic of drawing 5 is shown except for the early refractive index having set the thickness to 73.5 nm, using the thing of 2.3 as a super-resolution-reproducing film so that the reflectance of an optical recording medium might serve as the minimum on the regenerated light wavelength of 410 nm, and the optical recording medium of the same composition were used.

[0047]In such an optical recording medium, the reflectance of the optical recording medium in the case of changing with the lights in which the refractive index of a super-resolution-reproducing film exceeds a threshold to 2.32, 2.35, or 2.4 is shown in drawing 7, and a reflectance difference is shown in drawing 8.

[0048]Even if a refractive index change is as small as 0.02, the reflectance difference of an optical opening and an optical mask is over 10%.

[0049]As drawing 8 shows, that the variation of reflectance serves as the maximum is the wavelength which shifted for a while from 410 nm. Therefore, in order to actually make a reflectance difference into the maximum with a reproducing wave length, it is desirable to adjust a super-resolution-reproducing film and to make it the reflectance of an optical recording medium become the minimum at the time of an early refractive index.

[0050]Adjustment of the reflectance of the optical recording medium at the time of an early refractive index adjoins a super-resolution-reproducing film, can form an optical matching layer, and not only the method of controlling the thickness of a super-resolution-reproducing film but can adjust the refractive index and thickness of a matching layer according to the early refractive index and thickness of a super-resolution-reproducing film.

[0051]Variation deltan (n-n1) of the refractive index n1 to the refractive index n in early stages of a super-resolution-reproducing film which changed comparatively these results on a horizontal axis deltan/n, Thickness of a super-resolution-reproducing film is set to d, the case where ** and a lamination interference layer are not provided [the early refractive index 1.7 and the time] for O and the time of 2.3 in a vertical axis as reflectance difference deltaR/d per unit membrane thickness (nm^{-1}) is made into x, and it is shown in drawing 9.

[0052]When filling the relation which becomes delta R/d>delta n/nx0.007 and a lamination interference layer is adjusted, it turns out that the effect of this invention becomes remarkable. That is, it is necessary to adjust a lamination interference layer so that the relation mentioned

above according to the refractive index variation of a super-resolution-reproducing curtain may be filled. Specifically, deltaR can be adjusted with each refractive index and number of laminations of a high refractive index layer and a low refractive index layer. For example, if the combination of a low refractive index layer and a high refractive index layer is changed, as shown in drawing 10, maximum reflectance and the minimum reflectance will change.
[0053]There is a tendency for the maximum reflectance of an optical recording medium to be so high that the refractive index difference of a low refractive index layer and a high refractive index layer be large, for the minimum reflectance to become low, and for a reflectance difference to become large. The relation between reflectance difference Rmax-Rmin and deltaR/d was shown in drawing 11 as the maximum reflectance Rmax and the minimum reflectance Rmin. In drawing 11, also when the lamination interference layer is not arranged, it writes together.
[0054]deltaR/d increases rapidly in Rmax-Rmin>0.2 and the effect of providing a lamination interference layer becomes remarkable so that drawing 11 may show. Therefore, it is preferred to fill the relation which becomes delta R/d>delta n/nx0.007 as a lamination interference layer, and to fill Rmax-Rmin>0.2.
[0055]Although the refractive index mentioned above referred to the real part of the complex index of refraction and the extinction coefficient of the imaginary part was explained as 0, the case where the extinction coefficient of a super-resolution-reproducing film is not 0 is described. The optical recording medium of the same composition as drawing 1 shows the reflectance of an optical recording medium in case the refractive index of a super-resolution-reproducing film is 2.3 and an extinction coefficient is 0, 0.1, 0.2, 0.5, or 1 to drawing 12. However, the thickness of the super-resolution-reproducing film could be 73.5 nm.
[0056]the maximum reflectance Rmax becomes low as an extinction coefficient becomes large so that drawing 12 may show, and the minimum reflectance Rmin becomes high -- Rmax-Rmin becomes small. Change of the reflectance from a high reflection region to a low reflection field becomes slow. For this reason, even if a refractive index changes in this situation, the reflectance differences of an optical opening and an optical mask will be few, and sufficient effect will not be acquired. Therefore, if it is a range with which Rmax-Rmin>0.2 is filled, even if a super-resolution-reproducing film has a limited extinction coefficient, it can acquire the effect of a laminated structure.
[0057]Especially as for this invention, to change of an extinction coefficient, when large, the effect is acquired for a refractive index change. In this case, since the reflectance change by the wavelength used as the minimum reflectance shifting becomes dominant, the reflectance difference a refractive-index front and after change can choose positive/negative freely by setting out of the wavelength used as the minimum reflectance.
[0058]Although the high refractive index layer or low refractive index layer used for a lamination interference layer had the respectively same refractive index in above-mentioned explanation, the high refractive index layer concerning this invention or a low refractive index layer should be [that a relative refractive index is high to ****** refractive index layers, or] just low. Namely, incident light should just fill the composition of a lamination interference layer which carries out a multiple echo between the 1st high refractive index layer and the 2nd refractive index layers.
[0059]If conditions which were mentioned above are fulfilled, the laminating order of a lamination interference layer, a recording layer, and a super-resolution-reproducing film can be designed arbitrarily.
[0060]Although the pit was formed in the transparent substrate and the transparent substrate and the recording layer were made to serve a double purpose in drawing 1, the recording layer concerning this invention can also consider the recording layer in which the field where optical properties differ it is not limited to this and respond up to picture information was formed as the composition laminated separately.
[0061]The high refractive index layer which adjoins the super-resolution-reproducing film shown in drawing 1 is omissible by using the material of a high refractive index as a super-resolution-reproducing film. That is, since the multiple echo and multiple interference of light will arise between a super-resolution-reproducing film and a high refractive index layer if the refractive index in early stages of a super-resolution-reproducing film is larger than the refractive index of

a low refractive index layer, the same effect as the optical recording medium shown by drawing 1 is acquired.
[0062]
[Example]Hereafter, the example of this invention is described with reference to drawings.
[0063]In example 1 this example, the optical recording medium of the laminated structure of low refractive index layer / transparent substrate / [high refractive index layer] x 3-/super resolution film / reflection film was used. A low refractive index layer / [high refractive index layer] x3 are the lamination interference layers by which a low refractive index layer and 3 sets of high refractive index layers were laminated.
[0064]Each layer was adjusted as follows so that super resolution reproducing could be performed, when regenerated light was the wavelength of 413 nm.
[0065]The pit (0.2 micrometer - 0.6 micrometer) formed in this PC board according to the track, respectively, using a polycarbonate (PC) board as a transparent substrate.
[0066]Thickness was taken as the thickness, 68.3 nm of low refractive index layers, and 42.7 nm of high refractive index layers by which optical film thickness is equivalent to lambda/4 at the low refractive index layer and the high refractive index layer using SiO_2 (refractive index: 1.5) and ZnS (refractive index: 2.4).
[0067]Refractive index: Using the super-resolution-reproducing film of 0, the thickness set 2.3 and an extinction coefficient to 73.5 nm so that the reflectance of an optical recording medium might serve as the minimum in the initial state with which regenerated light is not irradiated. If regenerated light is irradiated with this super-resolution-reproducing film, a refractive index will change to 2.4 only the central part of light spot.
[0068]The thickness is 50 nm, using AlTi in a reflection film.
[0069]Except that there was no comparative example 1 lamination interference layer, the disk of the same composition as this example was produced.
[0070]The pit length dependency of CNR (Carrier to Noise Ratio) was measured by the playback evaluator which used Kr+ gas laser as the light source for the disk of Example 1 and the comparative example 1. They are a reproducing wave length of 413 nm, and 1 mW of reproduction power.
[0071]The result was shown in drawing 13. When pit length is as long as 0.4 micrometers or more, the comparative example of CNR without a super-resolution-reproducing film is larger but so that drawing 13 may show, and if pit length becomes shorter than 0.4 micrometer, CNR will decrease rapidly. This is because sufficient super resolution effect is not acquired. On the other hand, the disk of this example is maintaining high CNR, even if pit length becomes short with 0.2 micrometer. From the above thing, it has checked that a multilayer dielectric had an effect in the improvement in the characteristic of a super-resolution-reproducing film.
[0072]In example 2 this example, the optical recording medium of the laminated structure of low refractive index layer / transparent substrate / [high refractive index layer] x 2-/low refractive index layer / super resolution film / matching layer / reflection film was used. A low refractive index layer / [high refractive index layer] x2 are the lamination interference layers by which a low refractive index layer and 2 sets of high refractive index layers were laminated.
[0073]Regenerated light used laser with a wavelength of 413 nm like Example 1.
[0074]About the transparent substrate, the low refractive index layer, the high refractive index layer, and the reflection film, it was considered as the same conditions as Examples 1, such as construction material and thickness.
[0075]The material of the same refractive index as Example 1 was used for the super-resolution-reproducing film. In this example, optical film thickness made thickness of the super-resolution-reproducing film the thickness equivalent to lambda/4, i.e., 44.9 nm.
[0076]AlN was used for the matching layer. The refractive index of AlN is 1.8. The thickness of the matching layer has been 100 nm so that reflectance may serve as the minimum in the initial state with which regenerated light is not irradiated. The thickness is 50 nm, using AlTi in a reflection film.
[0077]The same measurement as Example 1 was performed, and the same effect as Example 1 was checked.

The lamination of example 3 this example is the same lamination as Example 1. However, the refractive index used 2.2 and the extinction coefficient used the super-resolution-reproducing film of 0.4. As for this super-resolution-reproducing film, in a refractive index, 2.15 and an extinction coefficient change [the spot central part of regenerated light] with the exposures of regenerated light to 0.05.
[0078]The same measurement as Example 1 was performed, and the same effect was checked.
[0079]In example 4 this example, the optical recording medium of the laminated structure of a transparent substrate / low refractive index layer / [high refractive index layer] x3-/super-resolution-reproducing film / matching layer / recording layer / protective layer / reflecting layer was used.
[0080]Each layer was adjusted as follows so that super resolution reproducing could be performed, when regenerated light was the wavelength of 413 nm.
[0081]It is made to be the same as that of Example 2 about a high refractive index layer, a low refractive index layer, a super-resolution-reproducing film, a matching layer, and a reflection film, The phase change die materials of 20 nm of thickness which becomes a transparent substrate from germanium2Sb2Te5 without forming a record pit were separately provided as a recording layer, and it formed the ZnS-SiO two-layer of 40 nm of thickness as a protective layer.
[0082]Except for the point which does not form a high refractive index layer and a low refractive index layer for a comparative example 2 lamination interference layer, the same optical recording medium as Example 4 was created.
[0083]Record and reproduction were performed to the optical recording medium obtained by Example 4 and the comparative example 2 in the following ways.
[0084]413-nm laser performed the recording/reproduction wavelength and it reproduced by scanning and recording this laser by 6 m/s. Recording light set to 9 mW, and it recorded 0.3 micrometer of mark length's recording mark with single frequency, changing a mark interval.
[0085]Reproduction of this recorded information was set as 1 mW of reproduction power, and was performed. The result is shown in drawing 14.
[0086]When a mark interval is 0.3 micrometer or less so that drawing 14 may show, since the influence of intersymbol interference is strong, CNR is falling with the optical recording medium of the comparative example 2. Since the cross talk from an adjacent track is also large, the value of CNR does not become large even when the mark interval on a track is long.
[0087]On the other hand, in the optical recording medium of Example 4, at least 0.15 micrometer of mark intervals can be reproduced by high CNR. Since it is not influenced by a cross talk, the mark interval has been made also in the field over 0.3 micrometer more greatly [optical recording medium / of the comparative example 2] than CNR.
[0088]
[Effect of the Invention]Since the rate difference of a light reflex of the optical mask part and optical opening part of the optical recording medium which has a super-resolution-reproducing film can be enlarged according to this invention as mentioned above, it becomes possible to reproduce the recording mark of a ** mark pitch and a narrow track pitch by a high resolution.

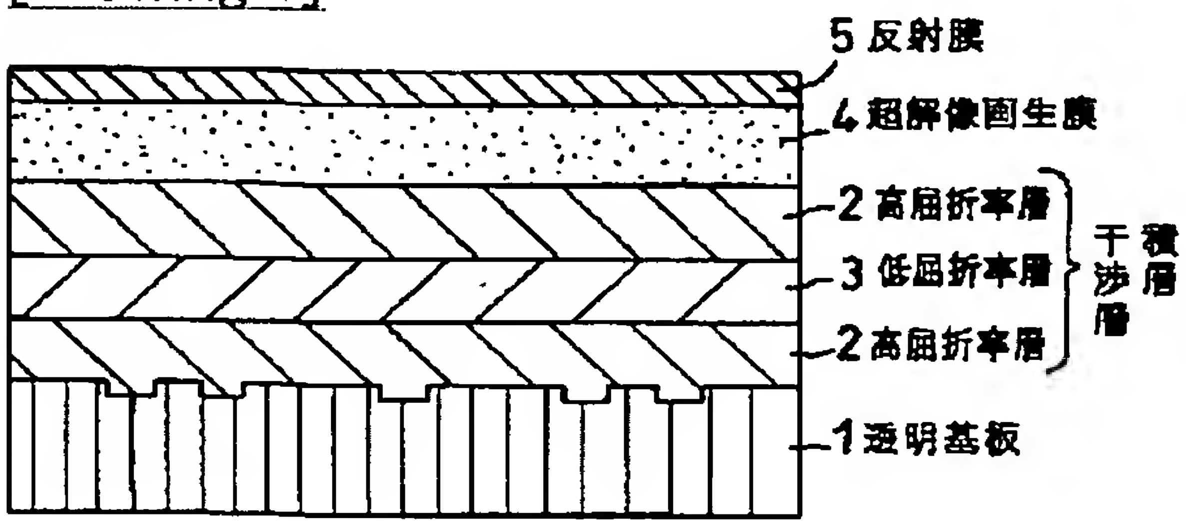
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]The sectional view showing an example of the optical recording medium of this invention.
[Drawing 2]The sectional view of a lamination interference layer.
[Drawing 3]Reflectance of a lamination interference layer.
[Drawing 4]The figure showing the reflectance of an optical recording medium when the number of laminations of a lamination interference layer changes.
[Drawing 5]The figure showing the reflectance change of an optical recording medium when the refractive index of the super-resolution-reproducing film of drawing 1 changes.
[Drawing 6]The refractive index change of a super-resolution-reproducing film [as opposed to / as opposed to / in (a) / the intensity distribution of an optical beam / the intensity of an optical beam in (b)] and (c) show the top view showing the optical property of an optical recording medium when this super-resolution-reproducing film is used for an optical recording medium.
[Drawing 7]The figure showing the reflectance change of the optical recording medium in the optical recording medium of another embodiment of this invention.
[Drawing 8]The figure showing the reflectance difference searched for from the reflectance change shown in drawing 6.
[Drawing 9]The figure showing the refractive index variation of a super-resolution-reproducing film, and the relation of the reflectance difference per thickness.
[Drawing 10]The figure showing change of the maximum reflectance by the difference in the refractive index of the layer which constitutes a lamination interference layer, and the minimum reflectance.
[Drawing 11]The figure showing the relation between the refractive index change of a super-resolution-reproducing film and thickness, and maximum reflectance and the minimum reflectance.
[Drawing 12]The figure showing the reflectance of an optical recording medium in case an extinction coefficient is not 0.
[Drawing 13]The figure showing the pit length dependency of CNR in the optical recording medium in this example 1.
[Drawing 14]The figure showing the mark length dependency of CNR in the optical recording medium of this example 4.
[Description of Notations]
1 -- Transparent substrate
2 -- High refractive index layer
3 -- Low refractive index layer
4 -- Super-resolution-reproducing film
5 -- Reflection film

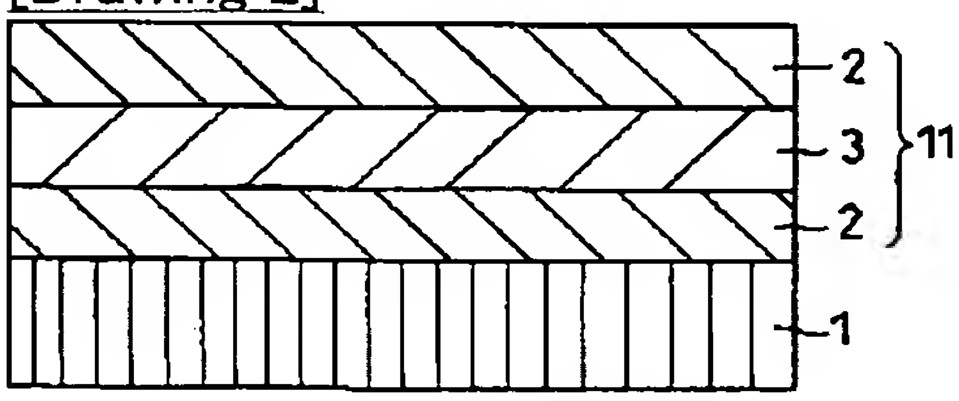
[Translation done.]

DRAWINGS

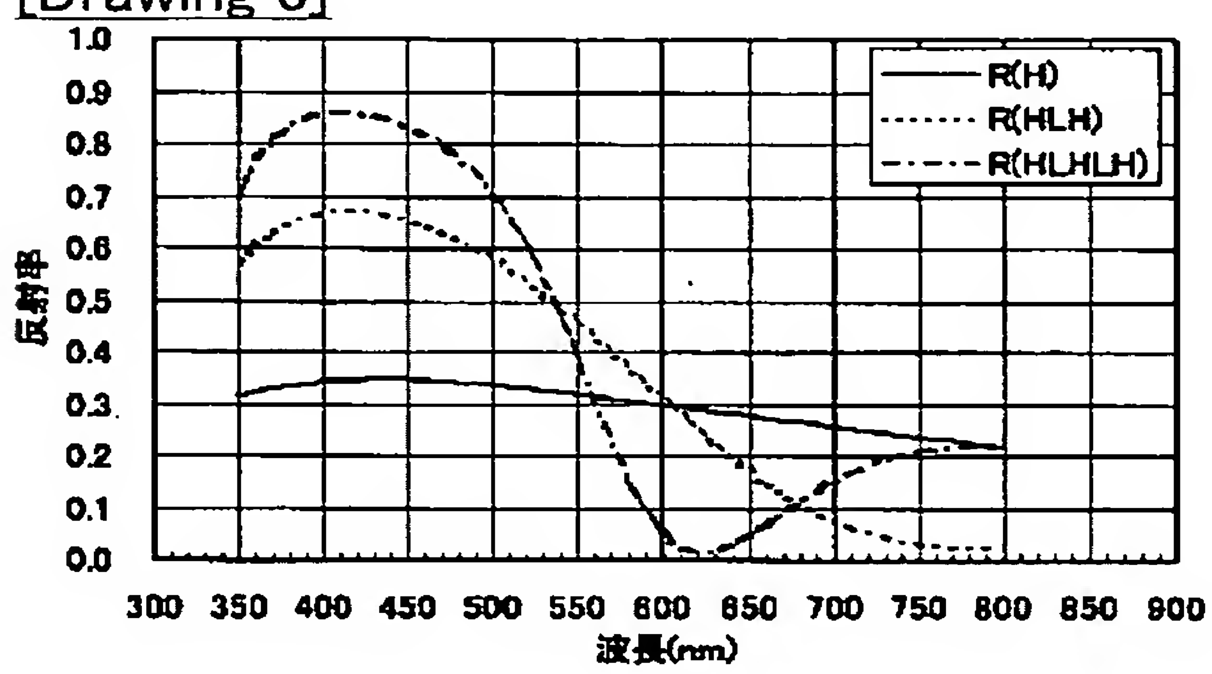
[Drawing 1]



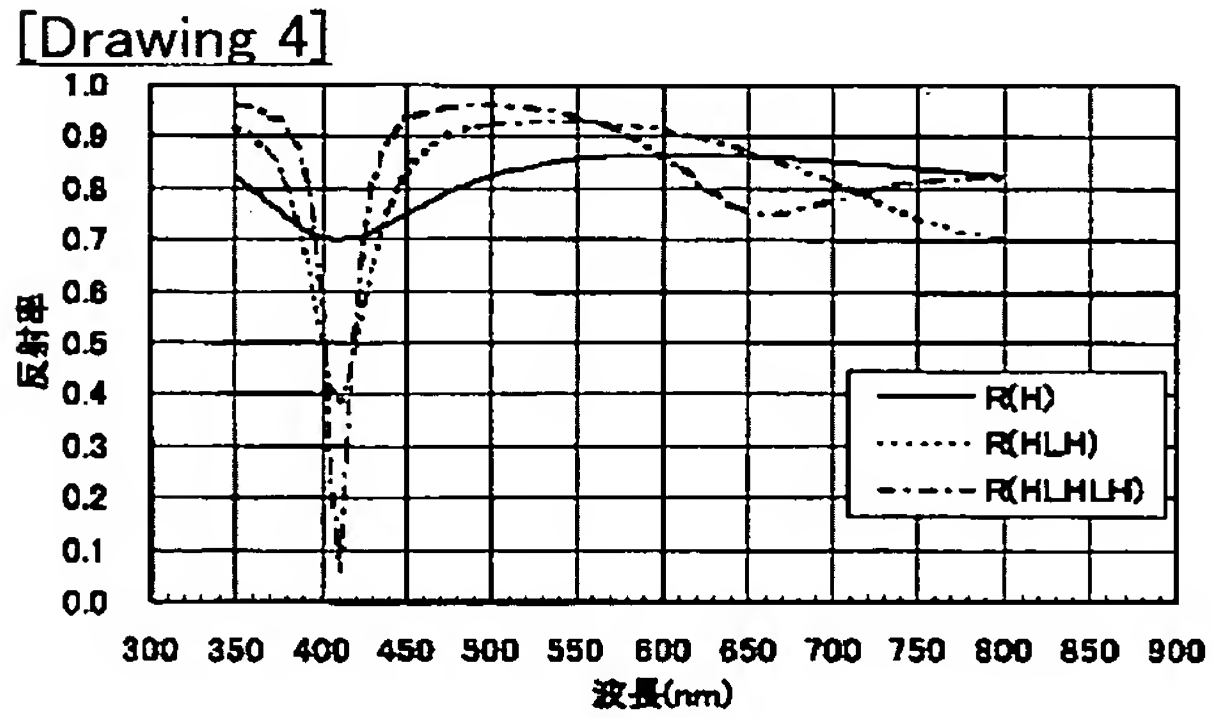
[Drawing 2]



[Drawing 3]



[Drawing 4]



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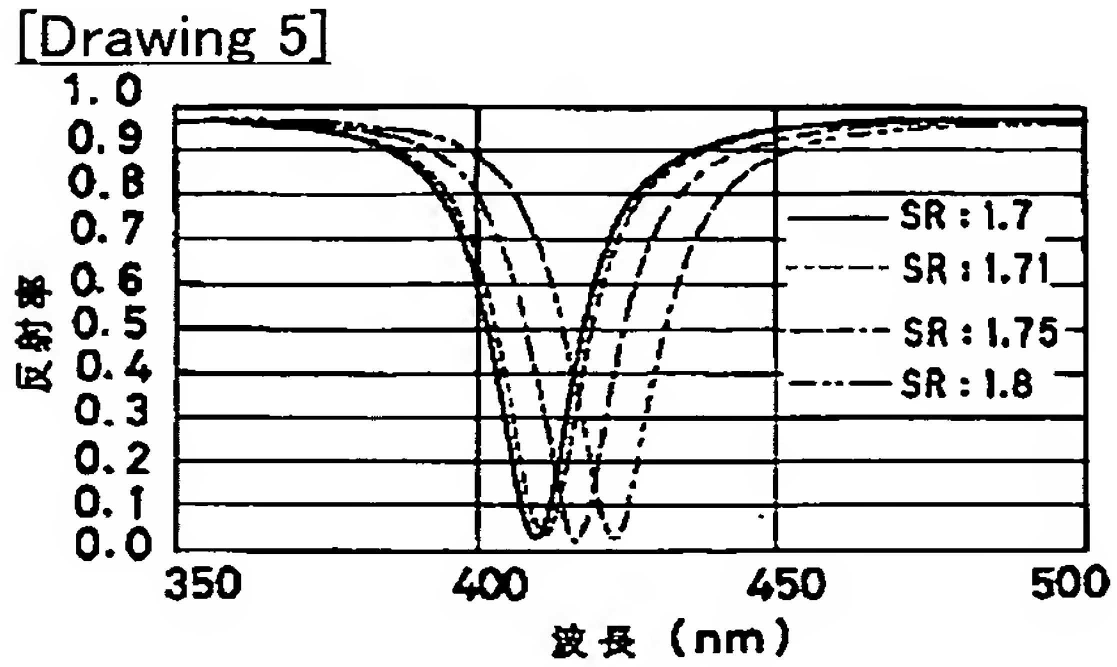

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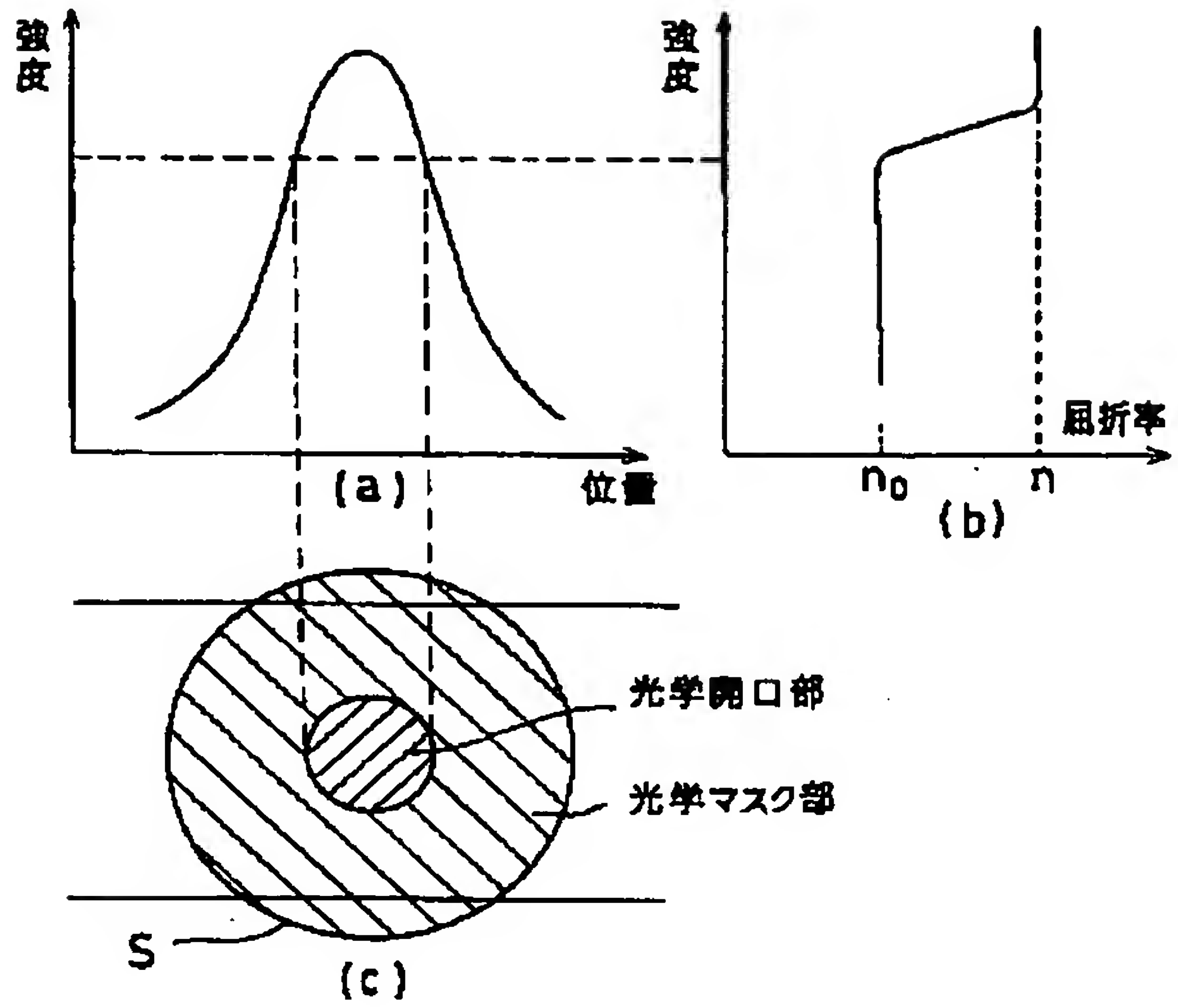

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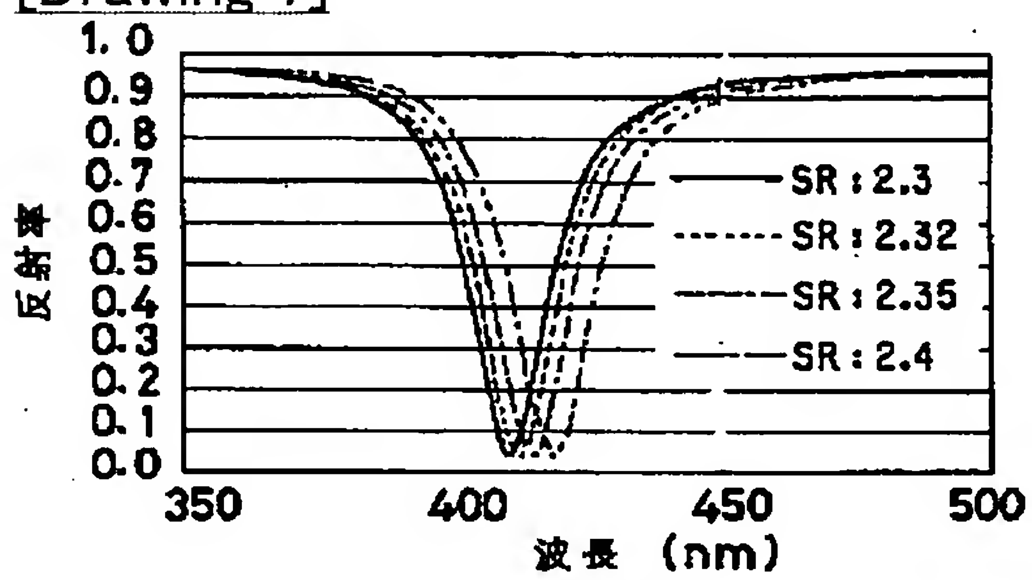

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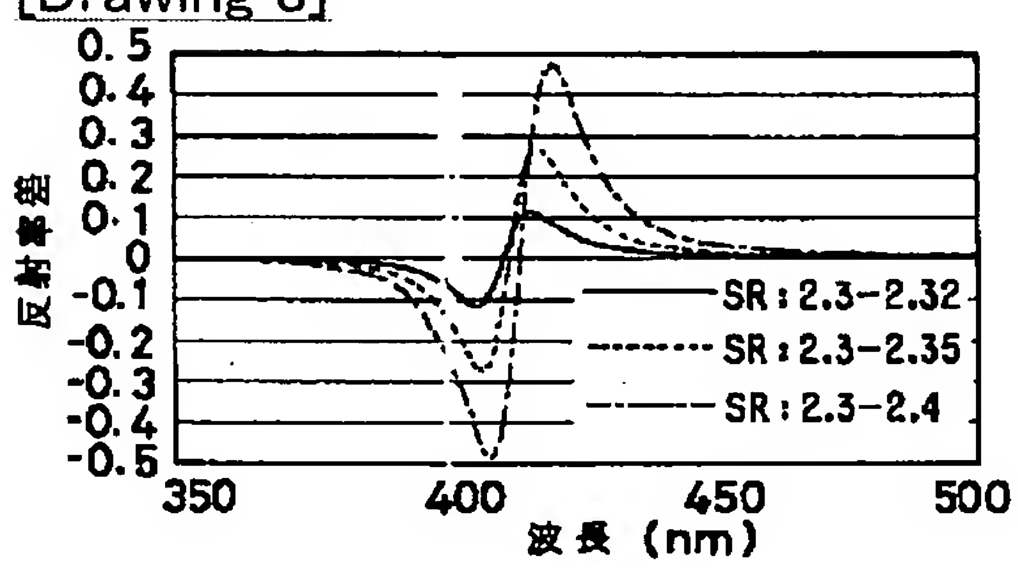
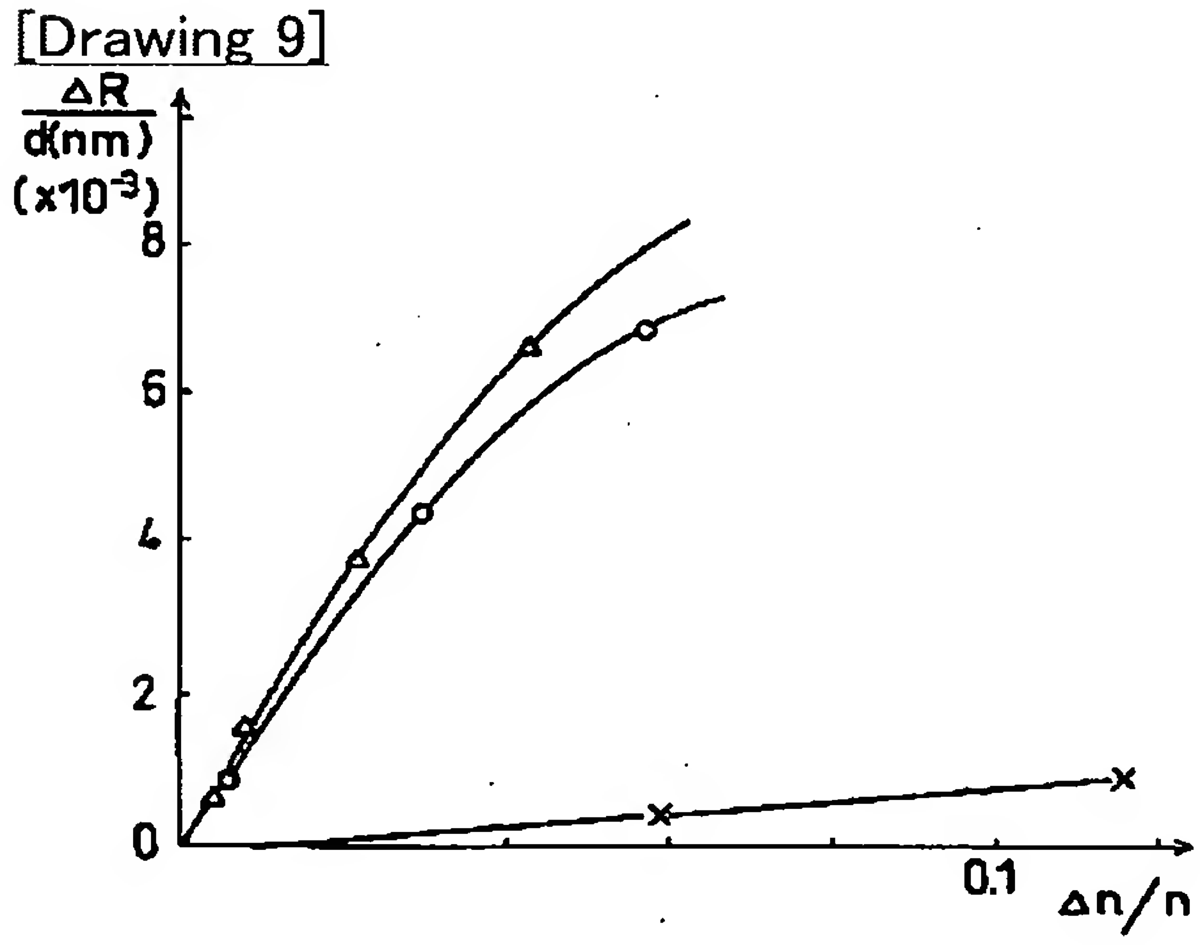
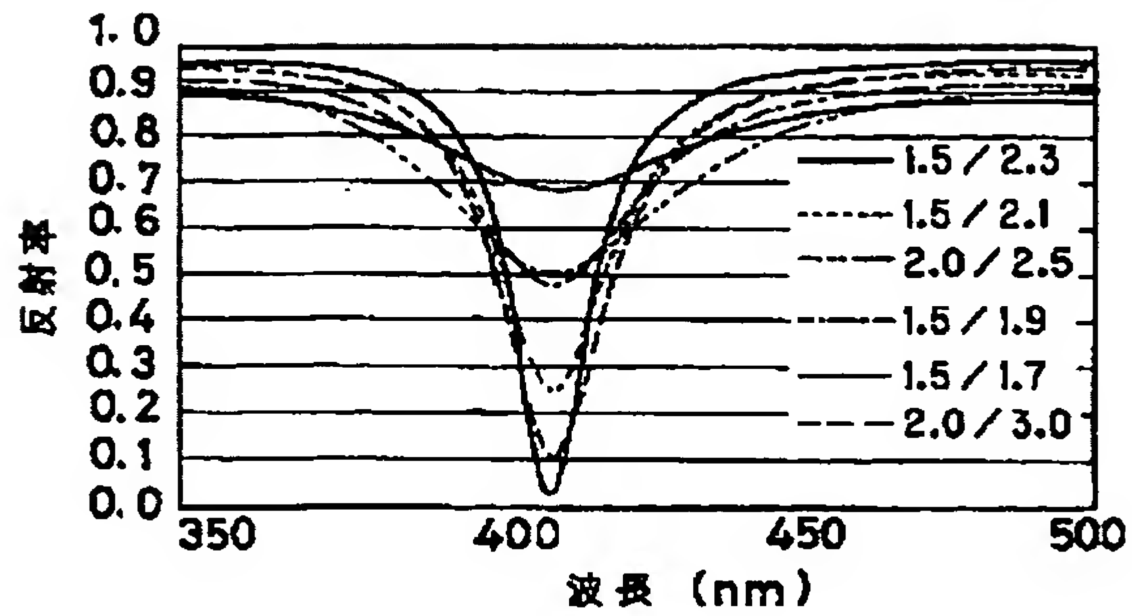


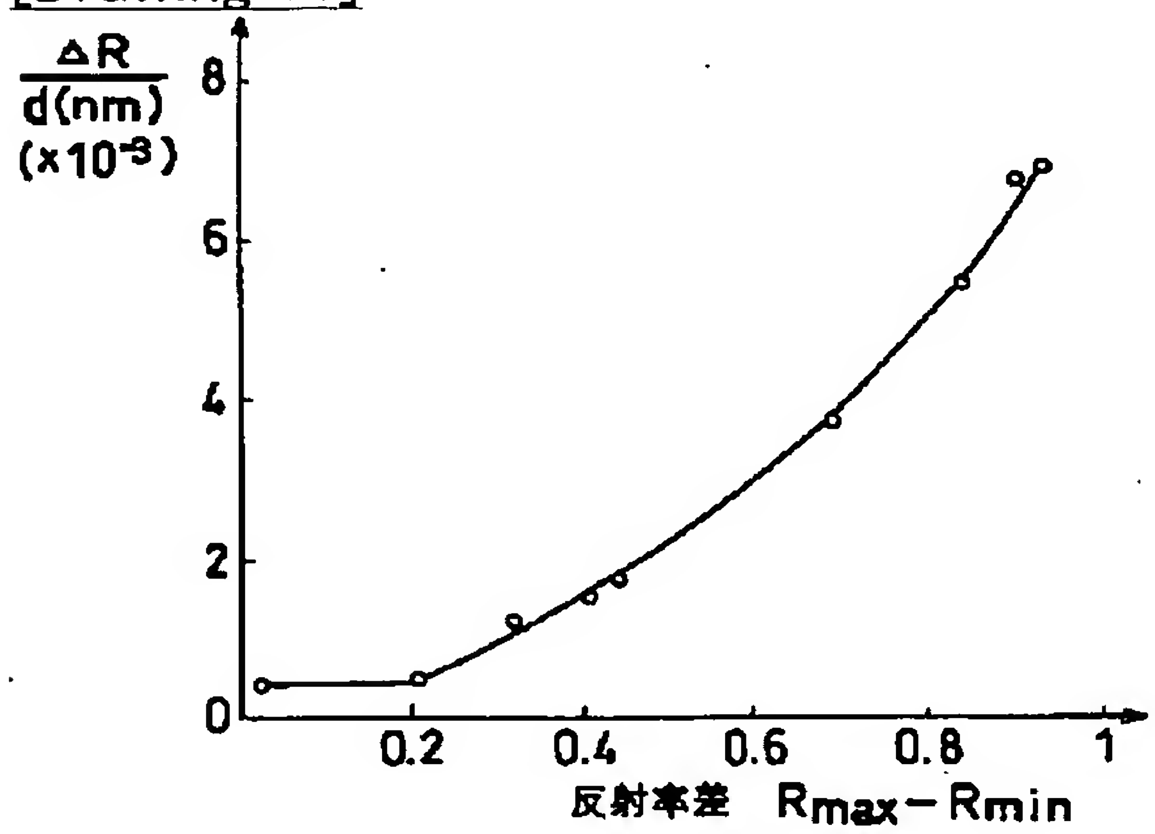
[Drawing 9]



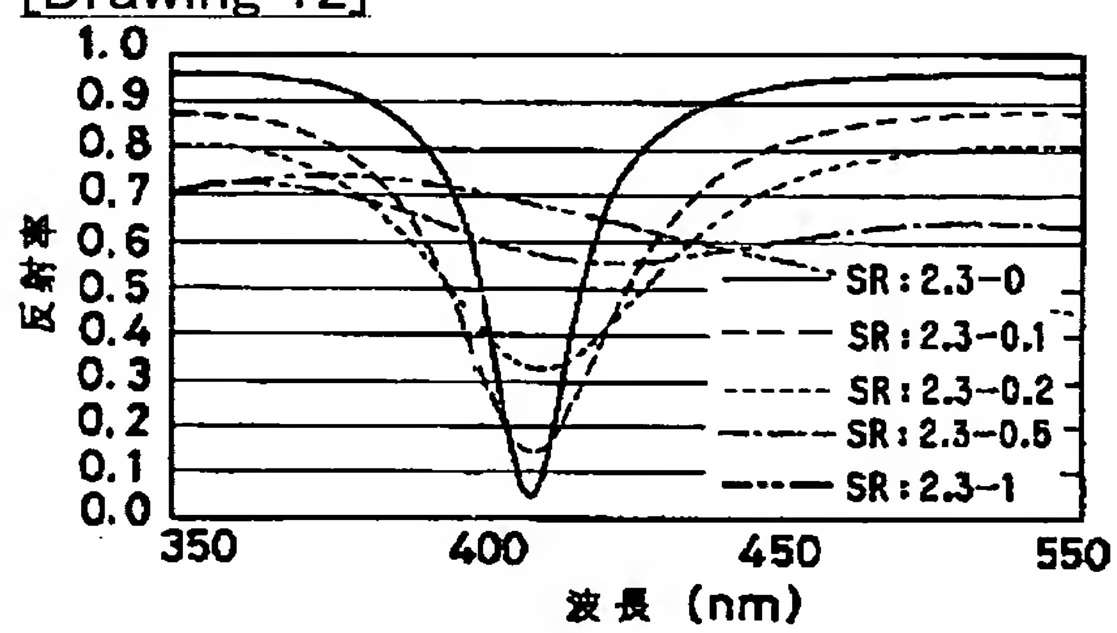
[Drawing 10]



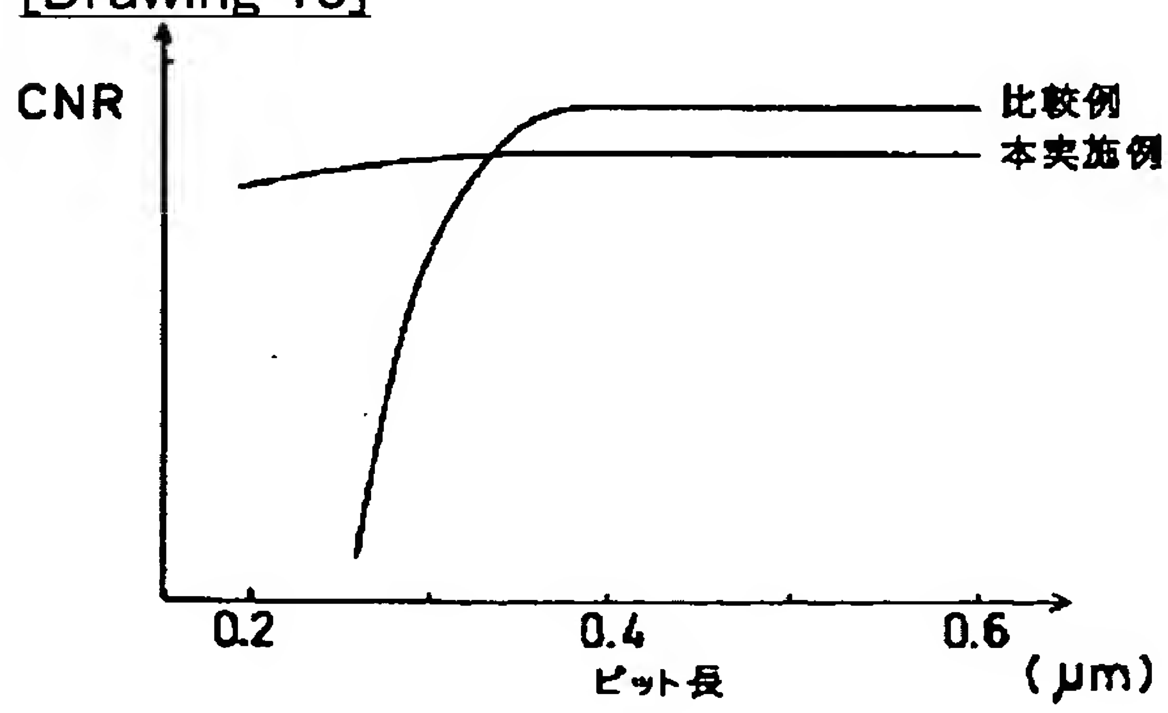
[Drawing 11]



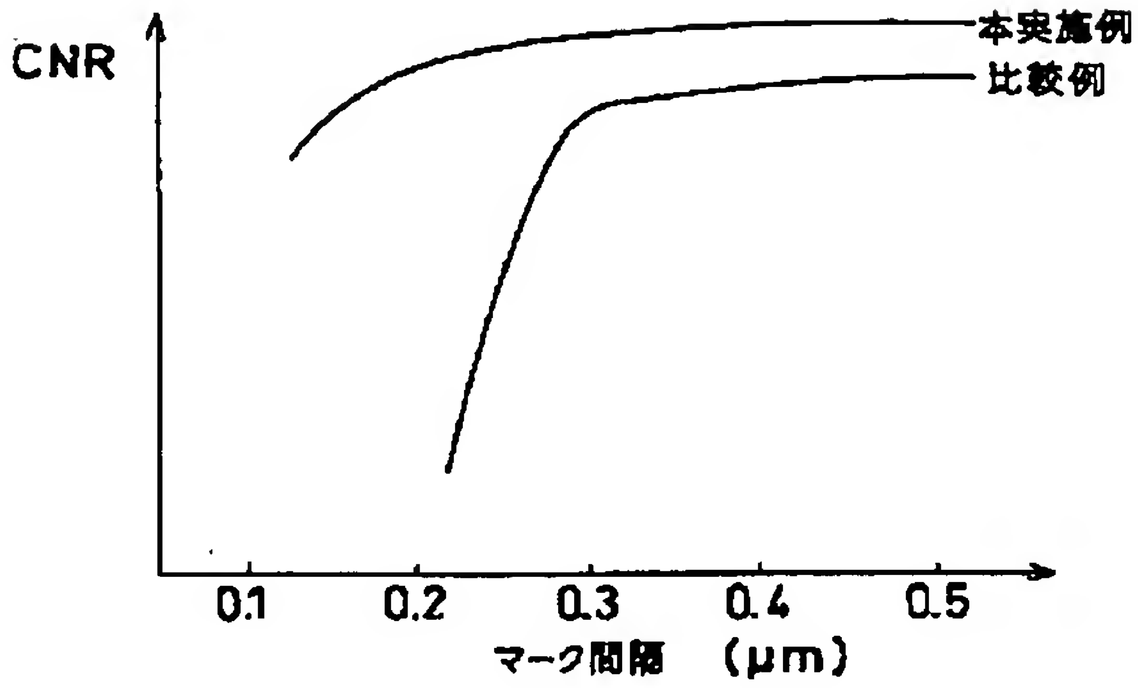
[Drawing 12]



[Drawing 13]



[Drawing 14]



[Translation done.]

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		５２２			５２２Ｆ	５Ｄ１２１
		５３３			５３３Ｒ	
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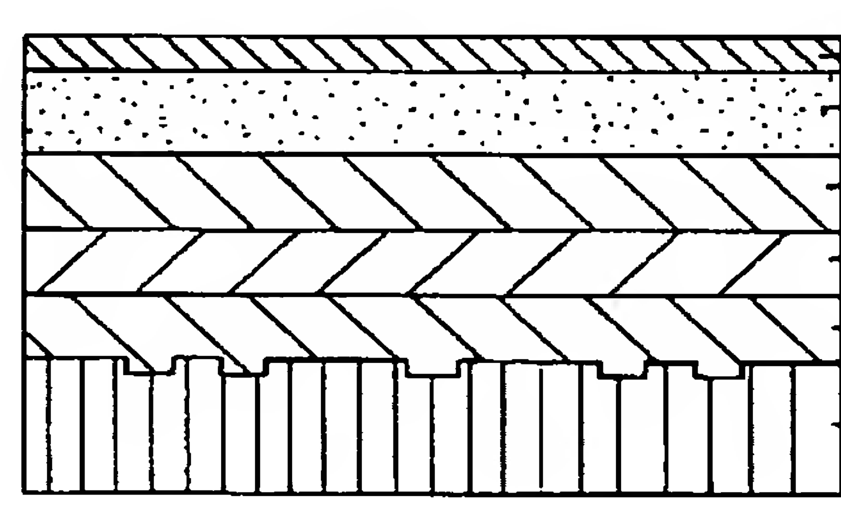
最終頁に続く

(54)【発明の名称】 光記録媒体

(57)【要約】

【課題】 超解像再生膜を具備する光記録媒体の光学マスク部と、光学開口部の反射率差を大きくする。

【解決手段】 記録層を兼ねた透明基板１、入射光強度により屈折率が変化する超解像再生膜４と反射膜５とを順次積層したことで、再生光の強度分布に応じて光学開口と光学マスクとが形成され、照射される光スポットよりも微小ピッチで書き込まれた記録情報を読取る光記録媒体において、超解像再生膜と反射膜との間に、それぞれ光学膜厚λ／４の高屈折率層２、低屈折率層３および高屈折率層２からなる積層干渉層１１を挿入することで、積層干渉層内で再生光が多重反射し、入射光および反射光とが多重干渉し、超解像再生膜の屈折率が変化した領域（光学開口）と変化しない領域（光学マスク）における光記録媒体の反射率差を大きくする。



【特許請求の範囲】

【請求項１】透明基板と、

この透明基板に対向して設けられ、前記透明基板側から照射される光を反射する反射層と、

前記基板及び前記反射層との間に任意の順に積層された、記録層、干渉層および前記光の照射量が所定の閾値を超えた時に屈折率が変化する超解像再生膜からなる積層体とを具備する光記録媒体において、

前記干渉層は、前記透明基板側から順に、所定の屈折率を有する第１の高屈折率層と、この第１の屈折率層よりも屈折率の低い低屈折率層と、この低屈折率層よりも屈折率の高い第２の屈折率層とからなる少なくとも３層を積層した積層干渉層であることを特徴とする光記録媒体。

【請求項２】前記超解像再生膜の初期の屈折率および変化した時の屈折率の差をΔn、前記超解像再生膜の屈折率が変化した時の反射率の差をΔR（$0<R\leqq 1$）、前記超解像再生膜の膜厚をd（nm）とした時、

$$\Delta R/d>\Delta n/n>0.007$$

を満たすことを特徴とする請求項１記載の光記録媒体。

【請求項３】記録情報を有する透明基板と、

この透明基板に対向して設けられ、前記透明基板側から照射される光を反射する反射層と、

前記基板及び前記反射層との間に任意の順に積層された、干渉層および前記光の照射量が所定の閾値を超えた時に屈折率が変化する超解像再生膜からなる積層体とを具備する光記録媒体において、

前記干渉層は、前記透明基板側から順に、所定の屈折率を有する第１の高屈折率層と、この第１の屈折率層よりも屈折率の低い低屈折率層と、この低屈折率層よりも屈折率の高い第２の屈折率層とからなる少なくとも３層を積層した積層干渉層であることを特徴とする光記録媒体。

【請求項４】前記超解像再生膜に隣接して設けられ、前記閾値を超えない光照射時に光記録媒体の反射率を最低とするように屈折率あるいは膜厚を制御した光学的マッチング層を有することを特徴とする請求項１記載の光記録媒体。

【請求項５】透明基板と、

この透明基板に対向して設けられ、前記透明基板側から照射される光を反射する反射膜と、

前記透明基板および前記反射膜間に形成され、光照射量が所定の閾値を超えた時に屈折率を変化させる超解像再生膜と、

この超解像再生膜表面に形成され、前記所定の閾値を超えない光を照射した時の前記超解像再生膜の屈折率よりも屈折率の低い低屈折率層と、

この低屈折率層表面に形成され、前記低屈折率層よりも屈折率の高い高屈折率層と、

前記透明基板および超解像再生膜間、又は前記高屈折率層および反射層間に形成された記録層とからなることを特徴とする光記録媒体。

【請求項６】透明基板側と、この透明基板に対向して設けられ、前記透明基板側から照射される光を反射する反射膜と、前記基板および反射膜との間に形成された、所定の閾値を超える強度の光照射によって屈折率が変化する超解像再生膜、干渉層、および記録層とを具備し、

前記透明基板側から照射される再生光に対する前記反射膜による反射光と、前記干渉層および前記超解像再生膜による反射光との干渉光を光記録媒体の反射光とし、前記超解像再生膜の屈折率変化領域に対応して反射光強度が異なる光記録媒体において、

前記干渉層は、記録媒体内で前記再生光が多重反射するように屈折率の異なる高屈折率層および低屈折率層を積層した積層干渉層であることを特徴とする光記録媒体。

【請求項７】記録情報を有する透明基板側と、この透明基板に対向して設けられ、前記透明基板側から照射される光を反射する反射膜と、前記基板および反射膜との間に形成された、所定の閾値を超える強度の光照射によって屈折率が変化する超解像再生膜、および干渉層とを具備し、

前記透明基板側から照射される再生光に対する前記反射膜による反射光と、前記干渉層および前記超解像再生膜による反射光との干渉光を光記録媒体の反射光とし、前記超解像再生膜の屈折率変化領域に対応して反射光強度が異なる光記録媒体において、

前記干渉層は、記録媒体内で前記再生光が多重反射するように屈折率の異なる高屈折率層および低屈折率層を積層した積層干渉層であることを特徴とする光記録媒体。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は光記録媒体に係わり、特に超解像再生膜を具備する光記録媒体に関する。

【０００２】

【従来の技術】光ビームの照射により情報の再生または記録・再生を行う光ディスクメモリは、大容量性、高速アクセス性、媒体可搬性を兼ね備えた記憶装置として音声、画像、計算機データなど各種ファイルに実用化されており、今後もその発展が期待されている。

【０００３】光ディスクの高密度化技術としては原盤カッティング用ガスレーザーの短波長化、動作光源である半導体レーザーの短波長化、対物レンズの高開口数化、光ディスクの薄板化が考えられている。さらに、記録可能な光ディスクにおいてはマーク長記録、ランド・グルーブ記録など種々のアプローチがある。

【０００４】また、光ディスクの高密度化の効果が大きい技術として、媒体膜を利用した超解像技術が提案されている。超解像技術は当初、光磁気ディスクに特有の技術として提案されていたが、その後、ＲＯＭディスクでも記録層に対して再生光照射側に、再生光の照射により

光の透過率が変化する超解像膜を設けて超解像再生する試みが報告されている。このように、超解像技術は光磁気ディスク、ＣＤ－ＲＯＭ、ＣＤ－Ｒ、ＷＯＲＭ、相変化型光記録媒体など全ての光ディスクに適用可能であることが分かった。

【０００５】従来の超解像再生技術で提案されている超解像再生膜はヒートモード方式とフォトンモード方式に大別される。ヒートモード方式では再生光照射による加熱で超解像再生膜に相転移などを発生させ、透過率の高い光学開口を形成する。この光学開口の形状は超解像再生膜の等温線と同一になる。

【０００６】フォトンモード方式では超解像再生膜としてフォトクロミック材料を用い、再生光照射による発色または消色を利用する。フォトクロミック材料は光照射より電子が基底準位から寿命の短い励起状態へ励起し、さらに励起準位から寿命の非常に長い準安定励起準位へ遷移して捕捉されることにより光吸収特性の変化を発現する。したがって、繰り返して再生するには準安定励起準位に捕捉された電子を基底状態へ脱励起して、いったん形成された光学開口を閉じる必要がある。また、フォトンモード方式の超解像再生膜として吸収飽和現象を利用した半導体連続膜あるいは半導体微粒子分散膜を用いた例もある。

【０００７】いずれの方式にせよ、超解像再生膜の特性は光照射による光学定数の変化の程度に依存し、光学定数の変化が大きいほど光スポット内で反射率の高い光学開口部と反射率の低い光学マスク部の反射率差を大きくする。ところが光学定数の変化量はその材料に依存するため、屈折率の変化を大きくして反射率差を大きくするには限界がある。反射率差を大きくできないと、超解像再生した際に、記録情報の読取り不良が発生する恐れがある。

【０００８】

【発明が解決しようとする課題】上述したように、超解像再生膜を使用した光記録媒体においては、光学マスク部と光学開口部との反射率差を大きくできないと、正しく記録情報を再生できないという問題があった。

【０００９】本発明は、このような問題に鑑みてなされたものであり、光学開口部と光学マスク部の反射率差を大きくし、高密度に記録された情報を正確に再生できる光記録媒体を提供することを目的とする。

【００１０】

【課題を解決するための手段】本発明の光記録媒体は、透明基板と、反射層と、前記基板及び反射層との間に任意の順に積層された、記録層、干渉層および光照射量が所定の閾値を超えた時に屈折率が変化する超解像再生膜からなる積層体とを具備する光記録媒体において、前記干渉層は、前記透明基板側から順に、所定の屈折率を有する第１の高屈折率層と、この第１の屈折率層よりも屈折率の低い低屈折率層と、この低屈折率層よりも屈折率の高い第２の屈折率層とからなる少なくとも３層を積層した積層干渉層であることを特徴とする。

【００１１】すなわち、光記録媒体に照射した光を多重反射させ、光記録媒体内で多重干渉した反射光を検出することで、超解像再生膜の屈折率変化に対応する反射光強度の変化を大きくすることを特徴としている。

【００１２】前記第１乃至第３の干渉層の膜厚は、光記録媒体に照射する再生光の波長λに対して、実質的にλ／４程度にすることが好ましい。

【００１３】また、前記超解像再生膜の屈折率が変化したときの、屈折率の変化をΔｎ、光記録媒体の反射率の差をΔＲ（０＜Ｒ≦１）、前記超解像再生膜の膜厚をｄ（ｎｍ）とした時、ΔＲ／ｄ＞Δｎ／ｎ×０．００７を満たすことが望ましい。

【００１４】すなわち、ΔＲ／ｄをΔｎ／ｎに対してより大きくすることで、超解像再生膜の屈折率変化に対応する反射光強度の変化を大きくすることが可能になる。具体的には、隣合う干渉層に対して高屈折率層、低屈折率層の組合せで積層数を増加させることで、より反射光強度の変化を大きくすることが可能となる。

【００１５】また、前記透明基板は、前記記録層を兼ねることができる。

【００１６】また、前記干渉層と反射層との間に光学的なマッチング層を挿入することが望ましい。

【００１７】また、本発明の別の記録媒体は、透明基板と、反射膜と、前記透明基板および反射膜間に形成され、光照射量が所定の閾値を超えた時に屈折率を変化させる超解像再生膜と、この超解像再生膜表面に形成され、前記所定の閾値を超えない光を照射した時の前記超解像再生膜の屈折率よりも屈折率の低い低屈折率層と、この低屈折率層表面に形成され、前記低屈折率層よりも屈折率の高い高屈折率層と、前記透明基板および超解像再生膜間、又は前記高屈折率層および反射層間に形成された記録層とからなることを特徴とする。

【００１８】本発明の、さらに別の光記録媒体は、透明基板側と、この透明基板に対向して設けられ、前記透明基板側から照射される光を反射する反射膜と、前記基板および反射膜との間に形成された、所定の閾値を超える強度の光照射によって屈折率が変化する超解像再生膜、干渉層、および記録層とを具備し、前記透明基板側から照射される再生光に対する前記反射膜による反射光と、前記干渉層および前記超解像再生膜による反射光との干渉光を光記録媒体の反射光とし、前記超解像再生膜の屈折率変化領域に対応して反射光強度が異なる光記録媒体において、前記干渉層は、記録媒体内で前記再生光が多重反射するように屈折率の異なる高屈折率層および低屈折率層を積層した積層干渉層であることを特徴とする。

【００１９】また、本発明の別の光記録媒体は、記録情報を有する透明基板側と、この透明基板に対向して設けられ、前記透明基板側から照射される光を反射する反射

膜と、前記基板および反射膜との間に形成された、所定の閾値を超える強度の光照射によって屈折率が変化する超解像再生膜、および干渉層とを具備し、前記透明基板側から照射される再生光に対する前記反射膜による反射光と、前記干渉層および前記超解像再生膜による反射光との干渉光を光記録媒体の反射光とし、前記超解像再生膜の屈折率変化領域に対応して反射光強度が異なる光記録媒体において、　前記干渉層は、記録媒体内で前記再生光が多重反射するように屈折率の異なる高屈折率層および低屈折率層を積層した積層干渉層であることを特徴とする。

【００２０】すなわち、光記録媒体内で多重反射・干渉が生じさせる構成であれば、積層干渉層は、高屈折率層、低屈折率層、低屈折率層の順に限らず、例えば低屈折率層、高屈折率層、低屈折率層の順に積層されたものであっても構わない。

【００２１】これらの光記録媒体においても、多重反射・多重干渉した反射光を検出できるため、超解像再生膜の屈折率変化に対応する反射光強度の変化をより大きくすることができる。

【００２２】

【発明の実施の形態】図１は、本発明の光記録媒体の一例を示す断面図である。

【００２３】石英基板（屈折率１.４５）からなる透明基板１には、記録情報がピットとして形成されている。この透明基板上には、ＺｎＳからなる光学膜厚λ／４の高屈折率層２（屈折率２．３５）およびMgF_2（屈折率１．４）からなる光学膜厚λ／４の低屈折率層３とが複数積層された積層干渉層１１が形成されている。さらに積層干渉層１１上には、超解像再生膜４及び反射膜５が順次積層されている。

【００２４】なお、前記屈折率および光学膜厚は、波長４１０ｎｍの光に対するものである。したがって、高屈折率層の膜厚は、４３．６ｎｍ、低屈折率層の膜厚ｈａ７０．７ｎｍとしてある。

【００２５】また、超解像再生膜は、後述する閾値を超えない光に対して屈折率が２．０のものを使用し、閾値を超えない光に対して、光記録媒体の反射率が最小になる膜厚、８６．５ｎｍとした。

【００２６】このような光記録媒体において、透明基板側から照射される再生光の前記反射率は、反射膜によって反射される光と、積層干渉層内で多重反射する光の干渉光の強さによって決定し、本発明は、反射膜によって反射した光と積層干渉層によって多重反射した光の干渉光を観測することで、超解像再生膜によって形成される光学マスクと光学開口とのＳ／Ｎ比を大きくすることを可能にしたものである。

【００２７】まず、積層干渉層の反射率について説明する。

【００２８】図２に積層干渉層の断面図を、図３に積層干渉層の反射率を示す。但し、各層の屈折率は前述した値であり、波長分散がないものとした。

【００２９】図２は、透明基板１と積層干渉層１１とから形成されており、その構成は、図１に示したものと同一である。

【００３０】図３中、Ｒ（Ｈ）は石英基板上に高屈折率層を１層形成した時、Ｒ（ＨＬＨ）は石英基板上に高屈折率層、低屈折率層、高屈折率層の３層を形成した時（図２で示す構成）、Ｒ（ＨＬＨＬＨ）は高屈折率層と低屈折率層とを交互に５層積層したときの反射率を示している。

【００３１】図３から分かるように、Ｒ（Ｈ）の場合には最大反射率は低く、また高反射率帯から低反射率帯へと変化する波長領域が広い。これに対し、Ｒ（ＨＬＨ）の場合、すなわち、一対の高屈折率層の層間で多重反射が生じる場合、最大反射率は高まり、また高反射率帯から低反射率帯へと変化する波長領域が狭くなる。すなわち、屈折率変化の急峻性が増大する。これは、低屈折率層と高屈折率層の積層数が多くなるほど、すなわち多重反射する機会が多くなるほど顕著である（反射率の計算法については、「光学薄膜　Ｈ．Ａ．Ｍａｃｌｅｏｄ著　小倉繁太郎他　訳　日刊工業新聞社」や、「光学薄膜　第２版　藤原史郎編　石黒浩三、池田英生、横田秀嗣著　共立出版」に記載）。

【００３２】また、図１に示す構造の光記録媒体の積層干渉層の積層数を変えて計算した反射スペクトルを図４に示した。積層数が増加するにしたがって、最大反射率と最小反射率の差が大きくなり、かつ変化が急峻になっていることが分かる。この傾向は、図３と同様に、積層数が増加するにつれて、干渉効果が顕著に現れ、反射率変化の急峻性が増す。

【００３３】次に、図１の超解像再生膜の屈折率が異なる場合の光記録媒体の反射率を図５に示す。図５に示すように、屈折率が増加するに伴い反射率が最小となる波長が長波長側にシフトする。

【００３４】例えば、超解像再膜の屈折率が１．７から１．８に変化した場合、波長４１０ｎｍ付近での光の反射率差は約０．７程度まで変化する。

【００３５】図５からも分かるように、この反射率差は、反射率変化が急峻であるほど大きくできる。

【００３６】次に、超解像再生膜について説明する。

【００３７】本発明に係る超解像再生膜は、所定の閾値以下の光に対して所定の屈折率（以下、初期の屈折率と呼ぶ）を有し、所定の閾値を超える光が照射された部分のみ、選択的に異なる屈折率（以下、超解像再生時の屈折率と呼ぶ）に変化する材料から形成される膜であり、一般にヒートモード系と、フォトンモード系のものが知られている。

【００３８】ヒートモード系の超解像再生膜とは、光ビーム照射による加熱で閾値を超える部分のみを選択的に

相転移などを発生させ、屈折率を変化させる。例えばカルコゲン系のＧｅＳｂＴｅ、ＡｇＩｎＳｂＴｅなどの相変化材料、ビアンスロン系、スピロピラン等のサーモクロミック材料などが挙げられる。

【００３９】フォトンモード系の超解像再生膜は、例えばフォトクロミック材料など光照射により発色又は消色を利用したものが挙げられる。フォトクロミック材料は光照射より電子が規定順位から寿命の短い励起状態へ励起し、さらに励起準位から寿命の非常に長い準安定励起準位へ遷移して補足されることにより屈折率を選択的に変化させる。具体的には、ピロベンゾピラン系分子、フルギド系分子、ジアリールエテン系分子、シクロファン系分子、アゾベンゼンなどが挙げられる。また、吸収飽和により光学定数が変化する半導体、半導体微粒子分散膜などが挙げられる。

【００４０】このような超解像再生膜には、閾値を超える光に対して高屈折率に変化するものと、低屈折率に変化するものとがあるが、ここでは前者の場合の超解像再生方法を説明する。

【００４１】図６（ａ）にレーザで発信する光ビームの強度分布、（ｂ）に光ビームの強度に対する超解像再生膜の屈折率変化を図示する。また（ｃ）は、この超解像再生膜を図１に示す光記録媒体に用いた時の、光記録媒体の光学特性を示す平面図を示す。

【００４２】光ビームは、一般に図６（ａ）に示すように強度分布を持ち、ビームの中心から離れるにしたがって、強度が弱まる。超解像再生膜は閾値を超える光ビームに対し、屈折率を初期の屈折率ｎからｎ$_1$に変化させる。ここで、ｎ＝１．７、ｎ＝１．８、光ビームの波長が４１０ｎｍの場合、図５に示すように屈折率１．７の位置では反射率が約２％であり、屈折率１．８の位置では反射率が約７０％となる。

【００４３】したがって、図６（ｃ）に示すように光スポットＳの中でも、屈折率が変化した領域のみ光を反射させ、初期の屈折率の位置では光を反射させない、すなわち、閾値を超える光照射部のみ光学開口部が形成され、この光学開口部に対応する範囲の記録情報を検出し、閾値以下の光照射部には光学マスク部が形成され、この光学マスクに対応する範囲の記録情報は検出されない。したがって、光スポットＳよりも狭ピッチで記録情報の読取り、すなわち超解像再生を可能にする。

【００４４】また、初期の屈折率時の光記録媒体の値の調整は、超解像再生膜の膜厚を制御する方法に限らず、超解像再生膜に隣接して光学的マッチング層を形成し、超解像再生膜の初期の屈折率および膜厚に応じて、マッチング層の屈折率および膜厚を調整することでも可能である。

【００４５】図５では、超解像再生膜の初期の屈折率が１．７の場合について説明したが、同様に初期の屈折率が２．３の場合について検討してみる。

【００４６】超解像再生膜として初期の屈折率が２．３のものを用い、その膜厚を再生光波長４１０ｎｍで光記録媒体の反射率が最低となるように７３．５ｎｍとしたことを除き図５の特性を示す光記録媒体と同様の構成の光記録媒体を用いた。

【００４７】このような光記録媒体において、超解像再生膜の屈折率が閾値を超える光によって２．３２、２．３５あるいは２．４に変化する場合の光記録媒体の反射率を図７に、反射率差を図８に示す。

【００４８】屈折率変化が０．０２と小さくても光学開口と光学マスクの反射率差は１０％を越えている。

【００４９】また、図８より分かるように、反射率の変化量が最大となるのは４１０ｎｍより少しずれた波長である。したがって、実際に再生波長で反射率差を最大とするためには、超解像再生膜を調整し、初期の屈折率のときに光記録媒体の反射率が最低になるようにすることが望ましい。

【００５０】また、初期の屈折率時の光記録媒体の反射率の調整は、超解像再生膜の膜厚を制御する方法に限らず、超解像再生膜に隣接して光学的マッチング層を形成し、超解像再生膜の初期の屈折率及び膜厚に応じて、マッチング層の屈折率及び膜厚を調整することでも可能である。

【００５１】これらの結果を、横軸に超解像再生膜初期の屈折率ｎに対する変化した屈折率ｎ$_1$の変化量Δｎ（ｎ－ｎ$_1$）の割合Δｎ／ｎ、超解像再生膜の膜厚をｄとし、縦軸に単位膜厚当たりの反射率差ΔＲ／ｄ（ｎｍ$^{-1}$）として、初期の屈折率１．７と時を○、２．３の時を△、また積層干渉層を設けなかった場合を×として図９に示す。

【００５２】ΔＲ／ｄ＞Δｎ／ｎ×０．００７なる関係を満たす時に積層干渉層を調整すると本発明の効果が顕著化することが分かる。つまり、超解像再生幕の屈折率変化量に応じて上述した関係を満たすように積層干渉層を調整する必要がある。具体的には、高屈折率層と低屈折率層のそれぞれの屈折率や積層数によってΔＲを調整することができる。例えば、低屈折率層と高屈折率層の組合せを変化させると、図１０に示すように最大反射率と最小反射率が変化する。

【００５３】低屈折率層と高屈折率層の屈折率差が大きいほど、光記録媒体の最大反射率は高く、最小反射率は低くなり、反射率差が大きくなる傾向がある。最大反射率Ｒｍａｘ、最小反射率Ｒｍｉｎとして、反射率差Ｒｍａｘ－ＲｍｉｎとΔＲ／ｄの関係を図１１に示した。図１１には、積層干渉層が配置されていない場合も併記する。

【００５４】図１１から分かるように、Ｒｍａｘ－Ｒｍｉｎ＞０．２の範囲で急激にΔＲ／ｄが増加し、積層干渉層を設けることの効果が顕著化する。したがって、積層干渉層として、ΔＲ／ｄ＞Δｎ／ｎ×０．００７な

る関係を満たし、かつＲｍａｘ－Ｒｍｉｎ＞０．２を満たすことが好ましい。

【００５５】なお、上述した屈折率とは複素屈折率の実部を指し、虚部の消衰係数を０として説明したが、超解像再生膜の消衰係数が０でない場合について述べる。図１と同様な構成の光記録媒体で、超解像再生膜の屈折率が２．３、消衰係数が０、０．１、０．２、０．５あるいは１の時の光記録媒体の反射率を図１２に示す。但し、超解像再生膜の膜厚は、７３．５ｎｍとした。

【００５６】図１２より分かるように、消衰係数が大きくなるにつれて最大反射率Ｒｍａｘは低くなり、最小反射率Ｒｍｉｎは高くなり、 Ｒｍａｘ－Ｒｍｉｎは小さくなる。また、高反射領域から低反射領域への反射率の変化が緩慢になる。このため、この状況で仮に屈折率が変化しても、光学開口と光学マスクの反射率差はわずかであり、十分な効果が得られない。したがって、Ｒｍａｘ－Ｒｍｉｎ＞０．２を満たす範囲であれば、超解像再生膜は有限の消衰係数を持っても、積層構造の効果を得ることができる。

【００５７】本発明は、屈折率変化が消衰係数の変化に対して大きい場合に特にその効果が得られる。この場合は、最小反射率となる波長がシフトすることによる反射率変化が支配的となるため、屈折率前と変化後の反射率差は最小反射率となる波長の設定により正負を自由に選択することができる。

【００５８】なお、上述の説明では、積層干渉層に用いられる高屈折率層あるいは低屈折率層は、それぞれ同一の屈折率を有するものであったが、本発明に係る高屈折率層、あるいは低屈折率層は、隣合う屈折率層に対して相対的な屈折率が高い、あるいは低いものであればよい。すなわち、第１の高屈折率層と第２の屈折率層との間で、入射光が多重反射する積層干渉層の構成を満たせばよい。

【００５９】また、上述したような条件を満たすものであれば、積層干渉層、記録層および超解像再生膜の積層順を任意に設計できる。

【００６０】さらに、図１においては、透明基板にピットを形成し、透明基板と記録層とを兼用したが、本発明に係る記録層は、これに限定されるものではなく、画像情報に応じたて光学特性の異なる領域が形成された記録層を別途積層した構成とすることも可能である。

【００６１】また、超解像再生膜として高屈折率の材料を用いることで、図１に示す超解像再生膜と隣接する高屈折率層を省略することができる。すなわち、超解像再生膜の初期の屈折率が、低屈折率層の屈折率よりも大きければ、超解像再生膜と高屈折率層との間で光の多重反射・多重干渉が生じるために、図１で示す光記録媒体と同様な効果が得られる。

【００６２】

【実施例】以下、本発明の実施例を図面を参照して説明する。

【００６３】実施例１

本実施例においては、透明基板／[低屈折率層／高屈折率層]×３／超解像膜／反射膜の積層構造の光記録媒体を用いた。なお[低屈折率層／高屈折率層]×３は、低屈折率層と高屈折率層が３組積層された積層干渉層である。

【００６４】それぞれの層は、再生光が波長４１３ｎｍの場合に超解像再生が行えるように、以下の通り調整した。

【００６５】透明基板としてポリカーボネート（ＰＣ）基板を用い、このＰＣ基板にはトラック別に０．２μｍ～０．６μｍのピットがそれぞれ形成した。

【００６６】低屈折率層及び高屈折率層には、SiO_2（屈折率：１．５）およびＺｎＳ（屈折率：２．４）を用い、膜厚は光学膜厚がλ／４に相当する膜厚、低屈折率層６８．３ｎｍ、高屈折率層４２．７ｎｍとした。

【００６７】屈折率：２．３、消衰係数は０の超解像再生膜を用い、その膜厚は、再生光が照射されていない初期状態において光記録媒体の反射率が最小となるように７３．５ｎｍとした。この超解像再生膜は再生光が照射されると光スポットの中心部のみ屈折率が２．４に変化する。

【００６８】反射膜にはＡｌＴｉを用い、その膜厚は５０ｎｍである。

【００６９】比較例１

積層干渉層がない以外は、本実施例と同様の構成のディスクを作製した。

【００７０】実施例１および比較例１のディスクをＫｒ＋ガスレーザーを光源とした再生評価機でＣＮＲ（Ｃａｒｒｉｅｒ ｔｏ Ｎｏｉｓｅ Ｒａｔｉｏ）のピット長依存性を測定した。なお、再生波長４１３ｎｍ、再生パワー１ｍＷである。

【００７１】その結果を図１３に示した。図１３からわかるように、ピット長が０．４μｍ以上と長い場合は、超解像再生膜が無い比較例の方がＣＮＲが大きいが、ピット長が０．４μｍよりも短くなると急激にＣＮＲが減少する。これは十分な超解像効果が得られていないためである。これに対し、本実施例のディスクはピット長が０．２μｍと短くなっても高いＣＮＲを維持している。以上のことから、多層誘電体が超解像再生膜の特性向上に効果があることが確認できた。

【００７２】実施例２

本実施例においては、透明基板／[低屈折率層／高屈折率層]×２／低屈折率層／超解像膜／マッチング層／反射膜の積層構造の光記録媒体を用いた。なお、[低屈折率層／高屈折率層]×２は、低屈折率層と高屈折率層が２組積層された積層干渉層である。

【００７３】再生光は実施例１と同様波長４１３ｎｍのレーザーを使用した。

【００７４】透明基板、低屈折率層、高屈折率層および反射膜については、材質、膜厚など実施例１と同じ条件とした。

【００７５】超解像再生膜は、実施例１と同じ屈折率の材料を用いた。本実施例においては超解像再生膜の膜厚を光学膜厚がλ／４に相当する膜厚、すなわち４４．９ｎｍにした。

【００７６】マッチング層にはＡｌＮを用いた。ＡｌＮの屈折率は１．８である。マッチング層の膜厚は、再生光が照射されていない初期状態において反射率が最小となるように１００ｎｍとしてある。反射膜にはＡｌＴｉを用い、その膜厚は５０ｎｍである。

【００７７】実施例１と同様の測定を行い、実施例１と同様の効果を確認した。

実施例３

本実施例の層構成は実施例１と同様の層構成である。但し、屈折率が２．２、消衰係数が０．４の超解像再生膜を用いた。この超解像再生膜は再生光の照射により、再生光のスポット中心部のみ屈折率が２．１５、消衰係数が０．０５に変化する。

【００７８】実施例１と同様の測定を行い、同様の効果を確認した。

【００７９】実施例４

本実施例においては、透明基板／[低屈折率層／高屈折率層]×３／超解像再生膜／マッチング層／記録層／保護層／反射層の積層構造の光記録媒体を用いた。

【００８０】それぞれの層は、再生光が波長４１３ｎｍの場合に超解像再生が行えるように、以下の通り調整した。

【００８１】高屈折率層、低屈折率層、超解像再生膜、マッチング層、反射膜については実施例２と同様にし、透明基板には記録ピットを形成せずに、$Ge_2Sb_2Te_5$からなる膜厚２０ｎｍの相変化型材料を記録層として別途設け、また保護層として膜厚４０ｎｍの$ZnS-SiO_2$層を形成した。

【００８２】比較例２

積層干渉層を高屈折率層および低屈折率層を形成しない点を除き実施例４と同じ光記録媒体を作成した。

【００８３】実施例４および比較例２で得られた光記録媒体に以下の要領で記録、再生を行った。

【００８４】記録・再生波長を４１３ｎｍのレーザーで行い、６ｍ／ｓでこのレーザーを走査して記録、再生を行った。記録光は９ｍＷとし、マーク長０.３μｍの記録マークをマーク間隔を変化させながら単一周波数で記録した。

【００８５】この記録情報の再生を、再生パワー１ｍＷに設定して行った。その結果を図１４に示す。

【００８６】図１４から分かるように、マーク間隔が０．３μｍ以下の時に、比較例２の光記録媒体では符号間干渉の影響が強いためにＣＮＲが低下している。また、隣接トラックからのクロストークも大きいためにトラック上のマーク間隔が長い場合でもＣＮＲの値は大きくならない。

【００８７】これに対し、実施例４の光記録媒体においてはマーク間隔が０．１５μｍでも高いＣＮＲで再生できる。またクロストークの影響を受けないために、マーク間隔が０．３μｍを超える領域でも比較例２の光記録媒体よりもＣＮＲよりも大きくできている。

【００８８】

【発明の効果】上述したように、本発明によれば超解像再生膜を有する光記録媒体の、光学マスク部と、光学開口部の光反射率差を大きくすることができるため、狭マークピッチ、狭トラックピッチの記録マークを高分解能で再生することが可能となる。

【図面の簡単な説明】

【図１】　本発明の光記録媒体の一例を示す断面図。

【図２】　積層干渉層の断面図。

【図３】　積層干渉層の反射率。

【図４】　積層干渉層の積層数が変化した時の光記録媒体の反射率を示す図。

【図５】　図１の超解像再生膜の屈折率が変化した場合の光記録媒体の反射率変化を示す図。

【図６】　（ａ）は光ビームの強度分布、（ｂ）は光ビームの強度に対する超解像再生膜の屈折率変化、（ｃ）はこの超解像再生膜を光記録媒体に用いた時の、光記録媒体の光学特性を示す平面図を示す。

【図７】　本発明の別の実施形態の光記録媒体における光記録媒体の反射率変化を示す図。

【図８】　図６に示す反射率変化から求めた反射率差を示す図。

【図９】　超解像再生膜の屈折率変化量と膜厚当たりの反射率差の関係を示す図。

【図１０】　積層干渉層を構成する層の屈折率の違いによる最大反射率および最小反射率の変化を示す図。

【図１１】　超解像再生膜の屈折率変化および膜厚と、最大反射率および最小反射率との関係を示す図。

【図１２】　消衰係数が０でない場合の光記録媒体の反射率を示す図。

【図１３】　本実施例１における光記録媒体におけるＣＮＲのビット長依存性を示す図。

【図１４】　本実施例４の光記録媒体におけるＣＮＲのマーク長依存性を示す図。

【符号の説明】

１…透明基板

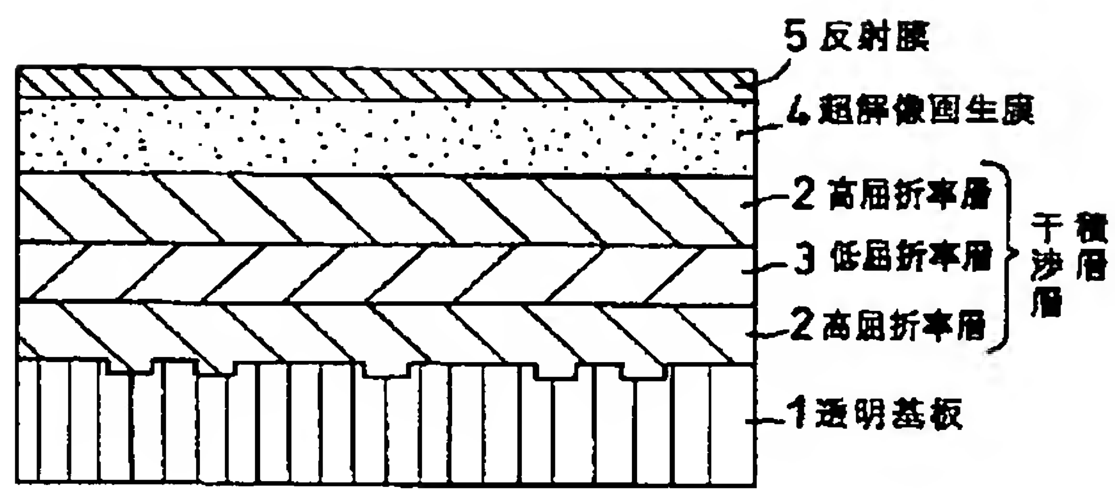
２…高屈折率層

３…低屈折率層

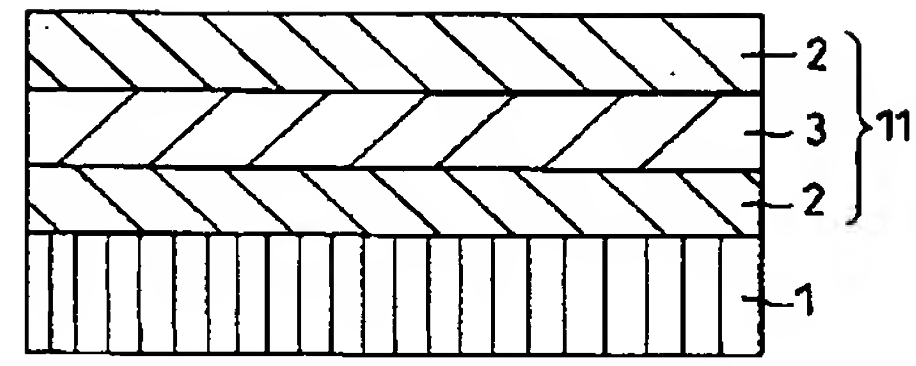
４…超解像再生膜

５…反射膜

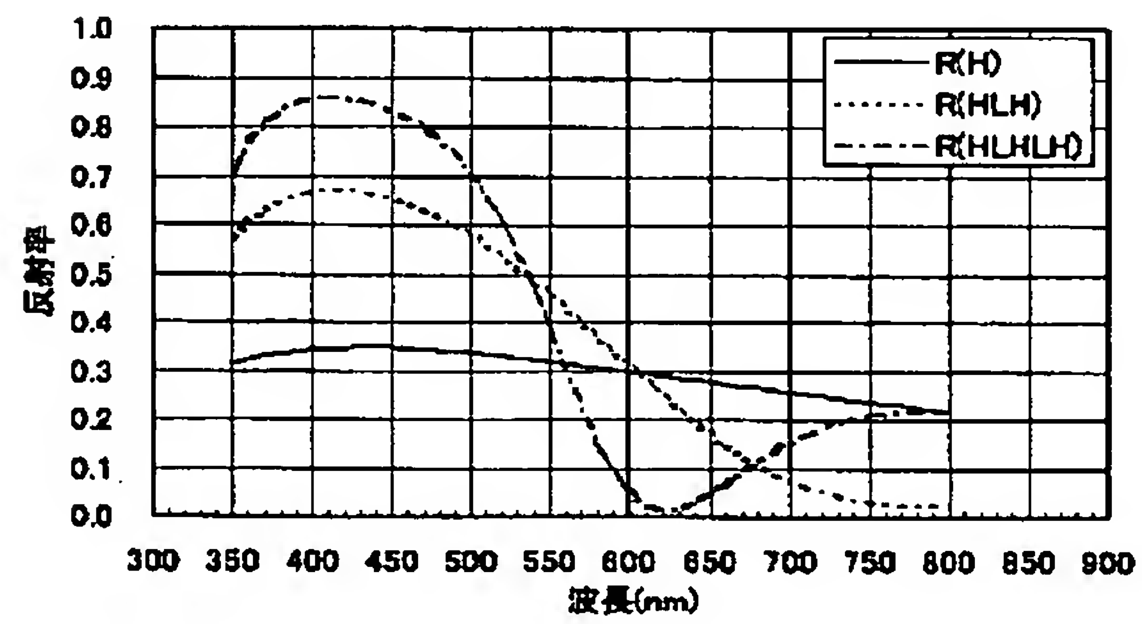
【図１】



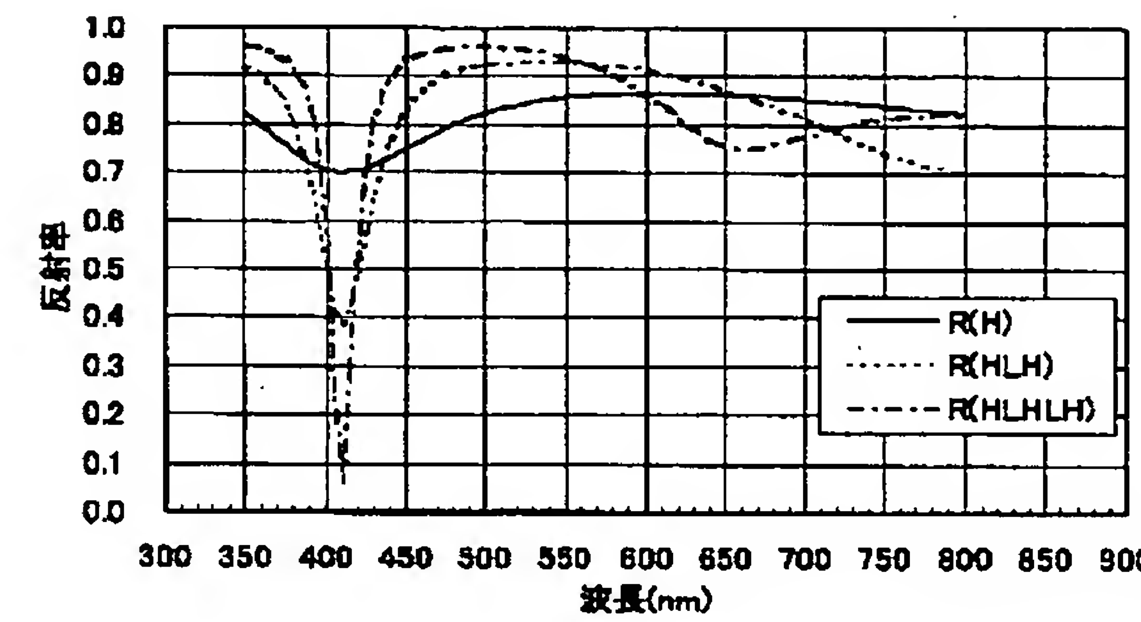
【図２】



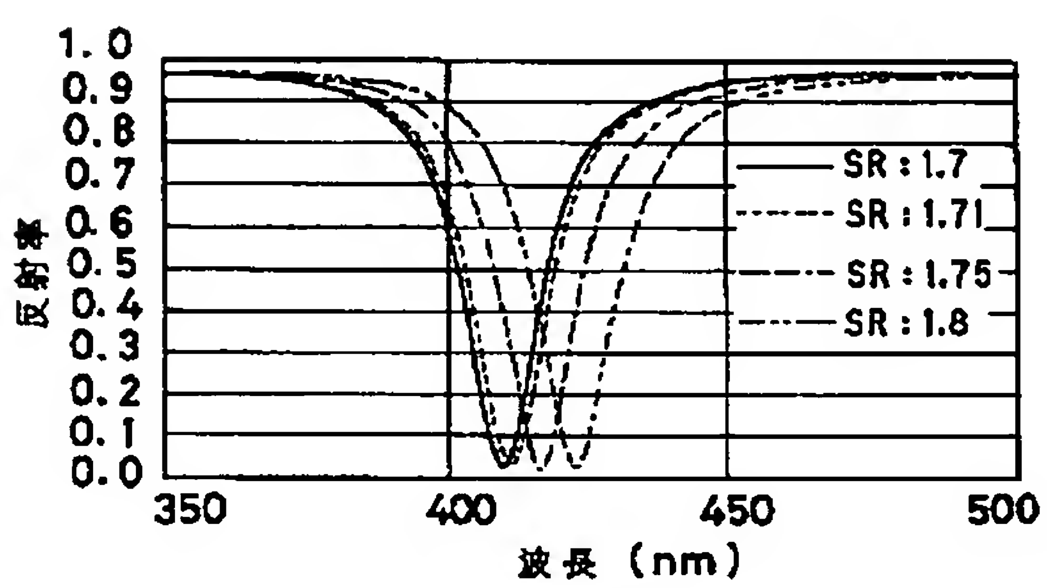
【図３】



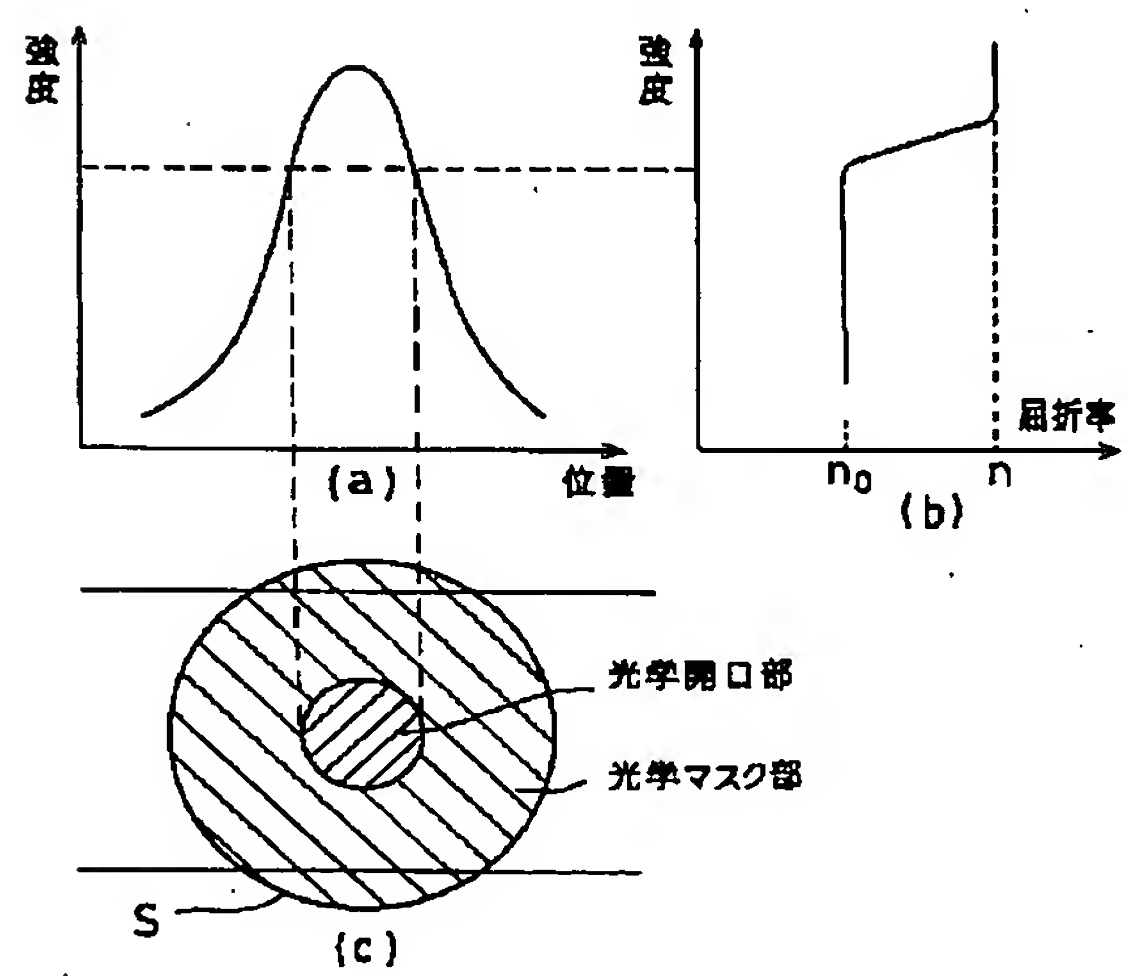
【図４】



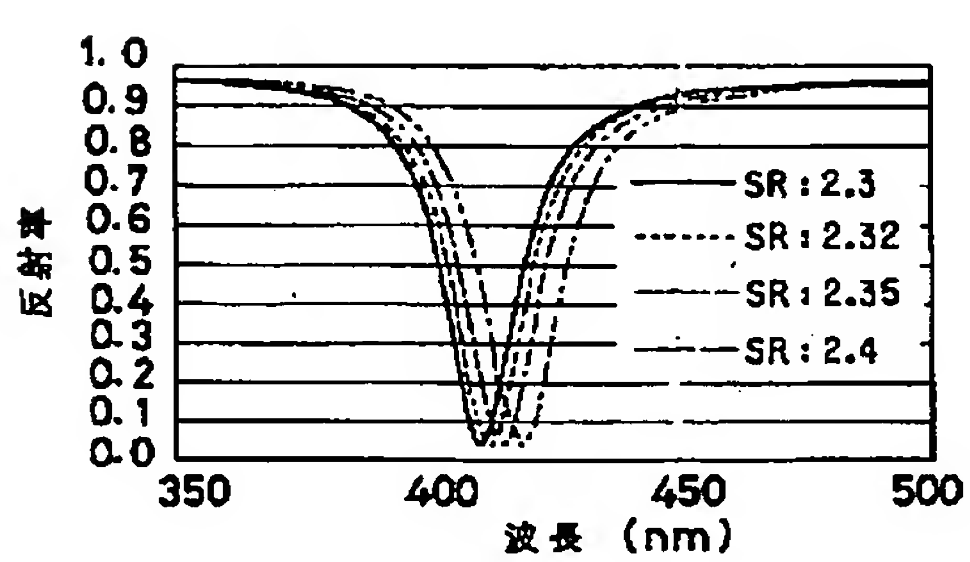
【図５】



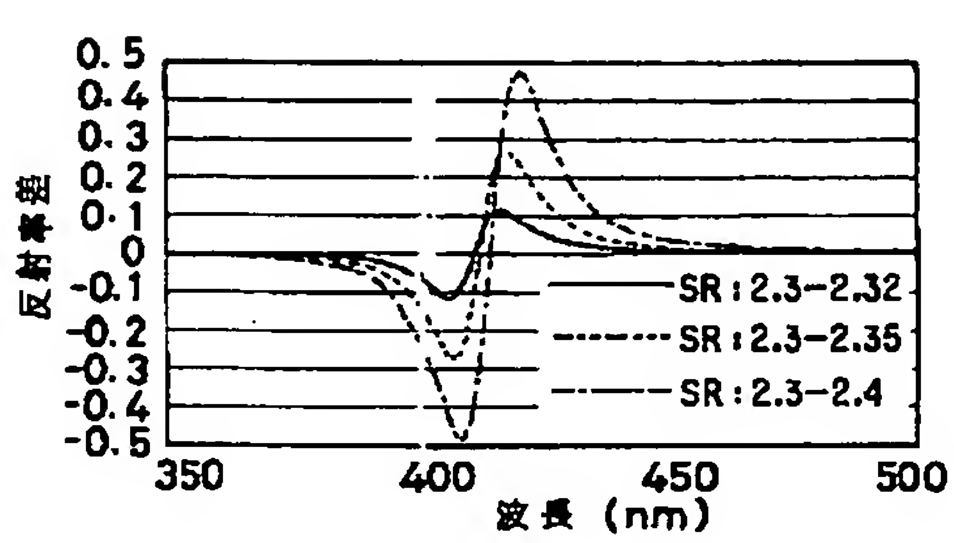
【図６】



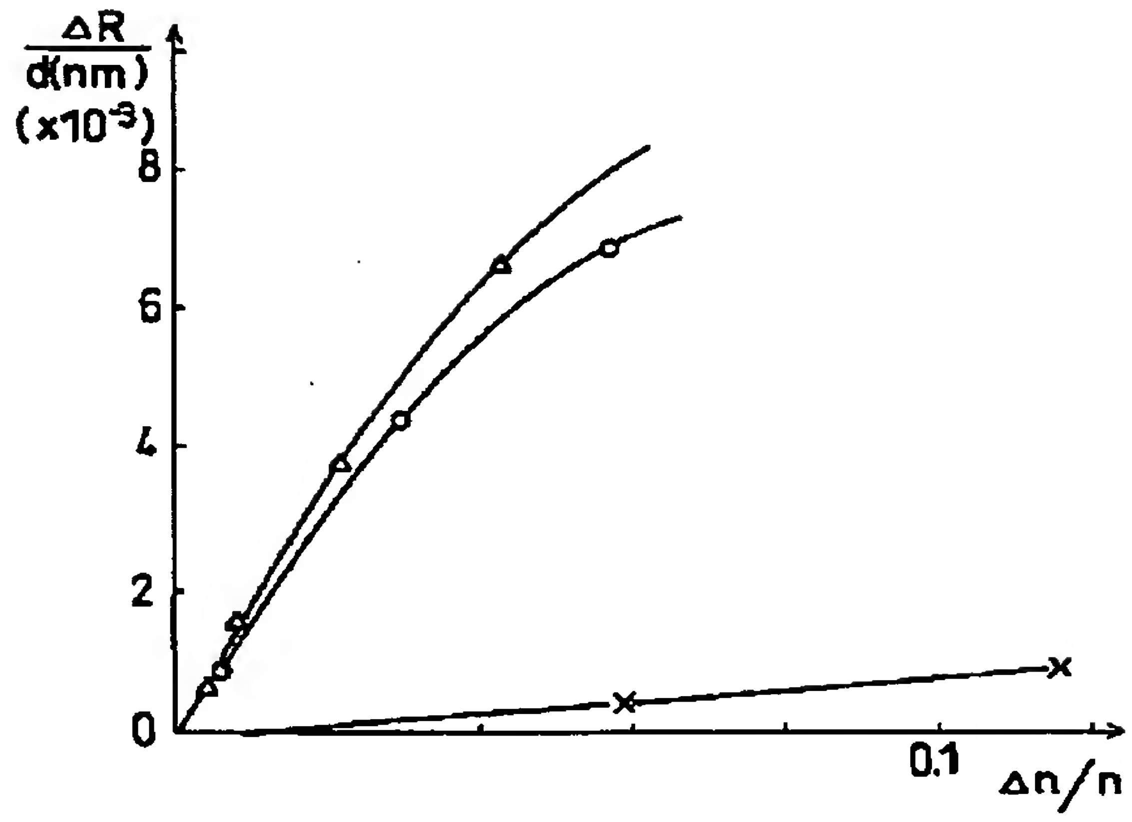
【図７】



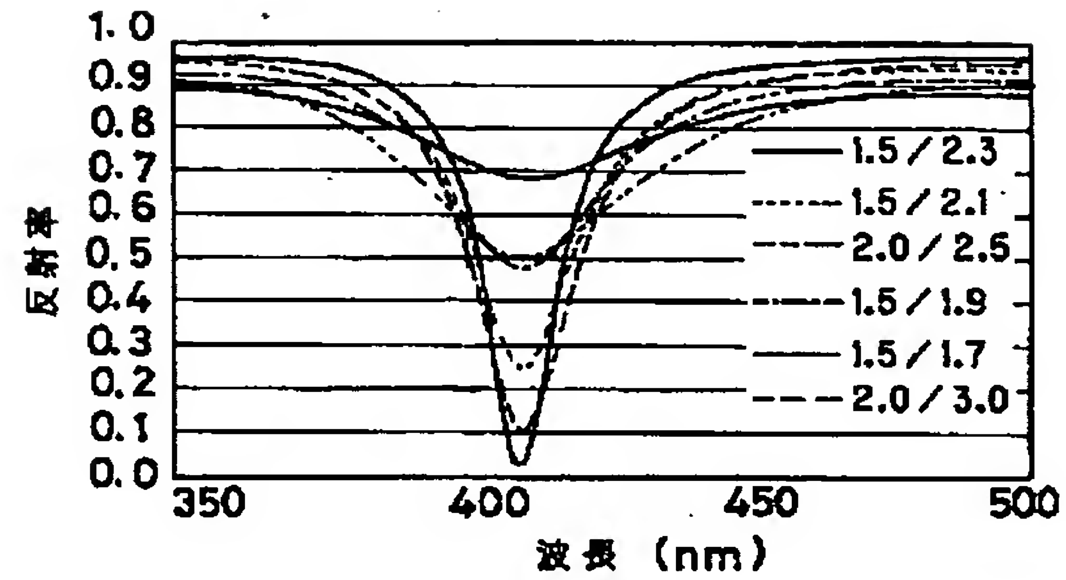
【図８】



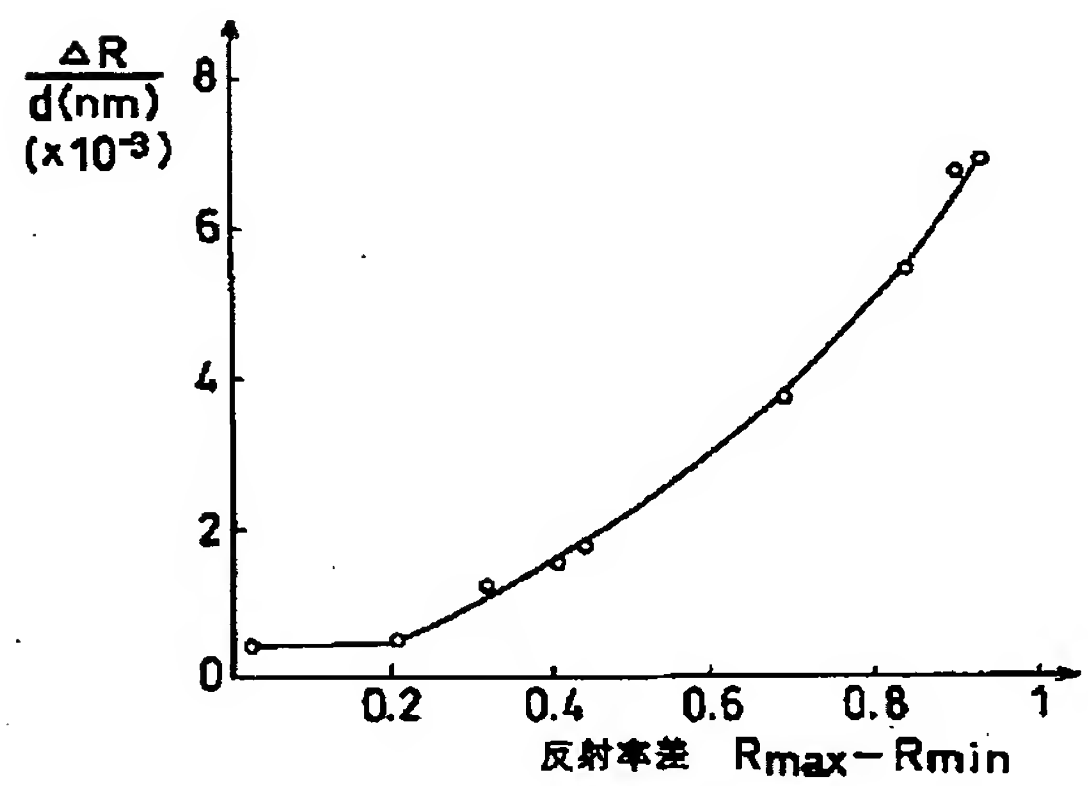
【図９】



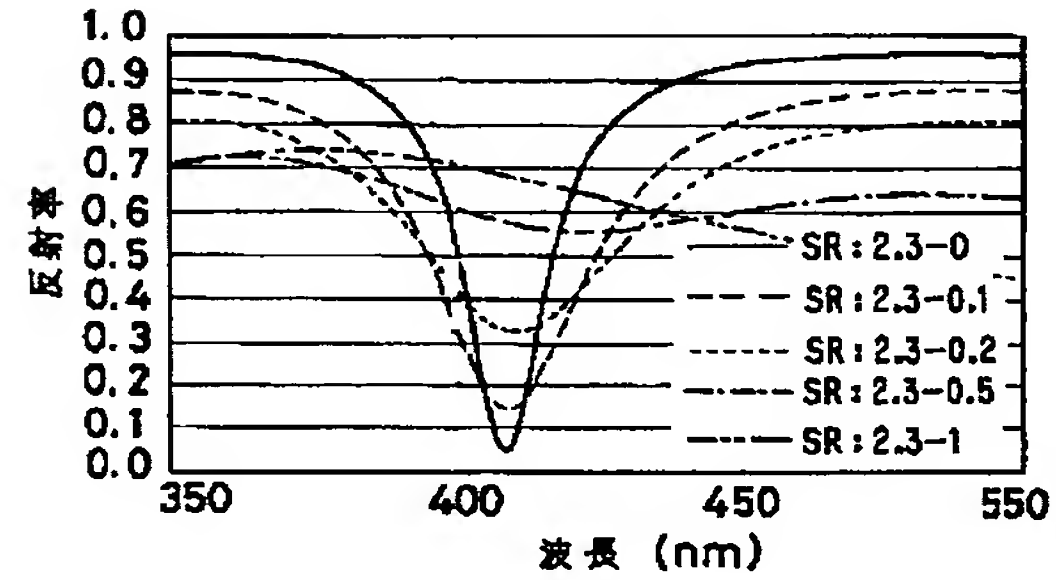
【図１０】



【図１１】



【図１２】



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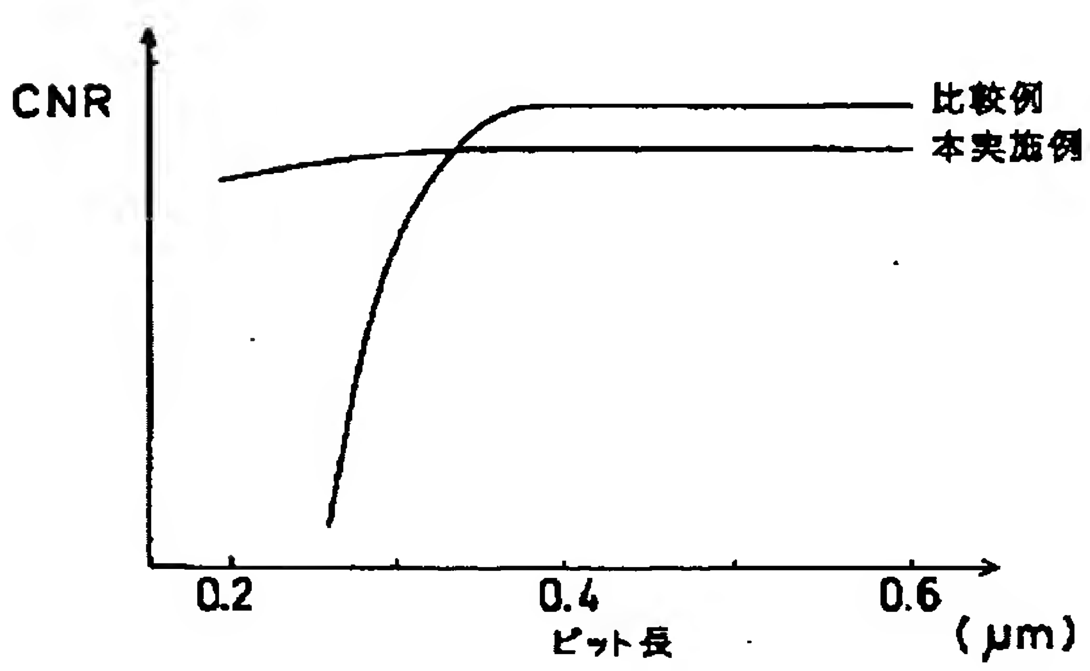
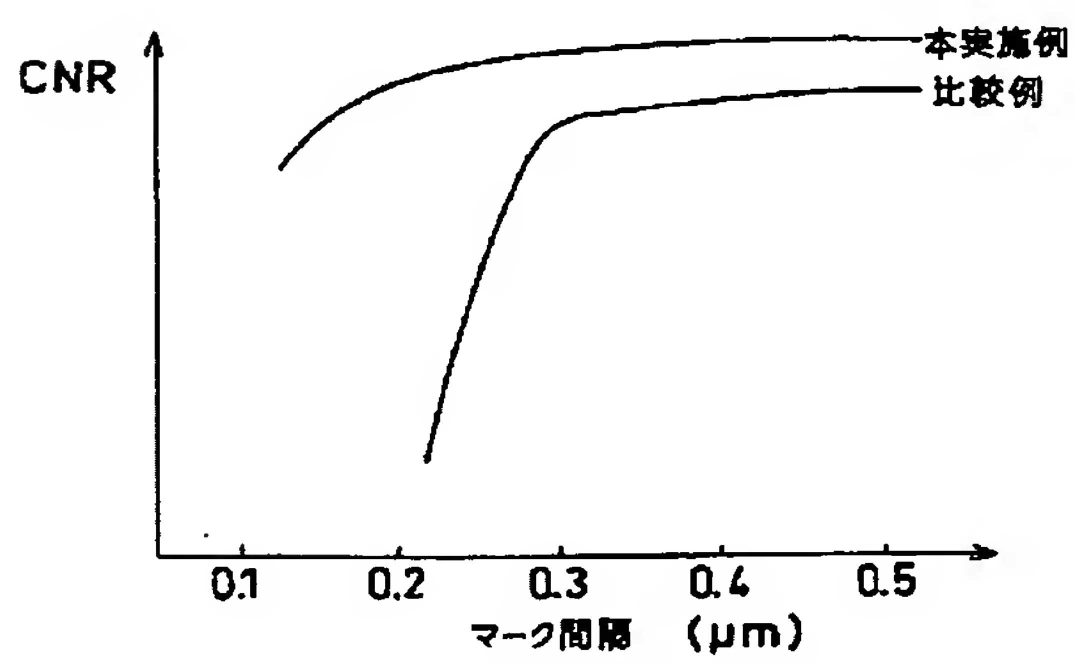


【図１４】



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